

Vol. I.

MAY, 1914

No. 5.

JOURNAL
OF THE
BOSTON SOCIETY
OF
CIVIL ENGINEERS



Published monthly, excepting July and August, by the Society,
715 Tremont Temple, Boston, Massachusetts.

Entered as second-class matter, January 15, 1914, at the Post Office at Boston, Mass.,
under Act of August 24, 1912.

Subscription Price, \$4.00 a year (Ten Numbers)
50 Cents a Copy

Copyright, 1914, by the Boston Society of Civil Engineers.

BOSTON SOCIETY OF CIVIL ENGINEERS

OFFICERS, 1914-1915

PRESIDENT

HARRISON P. EDDY

VICE-PRESIDENTS

CHARLES R. GOW

(Term expires March, 1915)

RICHARD A. HALE

(Term expires March, 1916)

SECRETARY AND LIBRARIAN

S. EVERETT TINKHAM

TREASURER

CHARLES W. SHERMAN

DIRECTORS

CHARLES B. BREED

(Term expires March, 1915)

JOHN N. FERGUSON

(Term expires March, 1915)

CHARLES M. ALLEN

(Term expires March, 1916)

LEONARD C. WASON

(Term expires March, 1916)

PAST PRESIDENTS

(Members of the Board)

CHARLES T. MAIN

JAMES W. ROLLINS

FREDERIC H. FAY

SPECIAL COMMITTEES

ON EXCURSIONS

LEONARD C. WASON

BERTRAM BREWER

LEONARD L. STREET

GEORGE A. SAMPSON

ON THE LIBRARY

S. EVERETT TINKHAM

FREDERIC I. WINSLOW

HENRY F. BRYANT

ON PUBLICATION

JOSEPH R. WORCESTER

RICHARD K. HALE

ARTHUR T. SAFFORD

ON MEMBERSHIP

F. H. FAY, Chairman

H. S. ADAMS

G. A. CARPENTER

J. E. CARTY

H. N. CHENEY

L. S. COWLES

R. E. CURTIS

A. W. DEAN

C. R. GOW

F. M. GUNBY

E. S. LARNED

L. B. MANLEY

I. E. MOULTROP

J. F. OSBORN

E. E. PETTEE

E. H. ROCKWELL

W. H. SAWYER

C. M. SPOFFORD

L. L. STREET

DAVID SUTTON

Editor—EDWARD C. SHERMAN

6 Beacon Street, Boston

BOSTON SOCIETY OF CIVIL ENGINEERS
FOUNDED 1848

PROCEEDINGS

PAPERS IN THIS NUMBER.

Report of Committee on Sewerage Statistics.

"The Collection and Treatment of Sewage in Their Relation to the City of Philadelphia." George S. Webster.

(Presented before the Sanitary Section, March 4, 1914.)

CURRENT DISCUSSIONS.

Paper.	Author.	Published.	Discussion Closes.
"Boston Foundations."	J. R. Worcester.	Jan.	May 10.
"Engineering Lessons from the Ohio Floods."	John W. Alford.	March.	May 15.
"Bitulithic Pavement and Warrenite Roadway."	G. H. Perkins.	March.	May 15.
"Cost Accounting on Construction Work."	Leslie H. Allen.	March.	May 15.

NOTE. At the request of a number of members of the Society the date of closing the discussion of "Boston Foundations" has been extended to May 10.

Reprints from this publication, which is copyrighted, may be made provided full credit is given to the author and the Society.

REGULAR MEETING.

A REGULAR meeting of the Boston Society of Civil Engineers will be held on Wednesday, May 20, 1914, at 7.45 o'clock P.M., in

CHIPMAN HALL, TREMONT TEMPLE, BOSTON.

Business of the Meeting.—To act on the vote passed at the last meeting, authorizing the Board of Government to use an appropriation from the Permanent Fund equivalent to the amount of the entrance fees for the fiscal year of 1913 and for the fiscal year of 1914. Under the By-Laws it requires an affirmative vote of two thirds at two successive regular meetings, to make an appropriation from the Permanent Fund.

Mr. Edward S. Larned will give a talk on "The Manufacture of Portland Cement," illustrated with motion pictures.

S. E. TINKHAM, *Secretary*.

JUNE EXCURSION OF SANITARY SECTION.

The annual June excursion of the Sanitary Section will be held Wednesday, June 3, 1914, at Fitchburg, Mass. The excursion will include an inspection of the new sewage treatment works, consisting of Imhoff tanks, sludge beds, sprinkling filters, secondary settling tanks, laboratory building, Venturi meter, and other features of interest.

Pamphlets will be provided giving the principal facts and detailed drawings of the plant.

All members of the Society and guests are invited.

A special notice will be mailed to members giving more detailed information in regard to the trip.

MINUTES OF MEETINGS.

BOSTON, March 25, 1914. — A special meeting of the Boston Society of Civil Engineers was held this evening at the Society Rooms, 715 Tremont Temple, and was called to order at 8 o'clock by the President, Mr. Harrison P. Eddy. In the absence of the Secretary, Mr. James E. Stone was elected Secretary *pro tem*. There were 52 members and guests present.

Mr. Leslie H. Allen read the paper of the evening, entitled "Cost Accounting on Construction Work."

The remainder of the meeting was devoted to a discussion of Mr. Allen's paper. Written discussions by Mr. Dana M. Wood, member of the Society, and by Mr. M. L. Cooley, of Cooley & Marvin Company of Boston, were presented and read. The paper was further discussed by Dr. Seldon O. Martin, of Harvard University; Mr. C. Oliver Wellington, of Clinton H. Scovell Co.; Mr. Merton W. Hopkins, of the New England Concrete Construction Co.; and by Mr. Burtis S. Brown, Mr. Bertram Brewer, President Eddy and Mr. Allen of the Society.

At 9.45 o'clock the meeting adjourned.

JAMES E. STONE, *Secretary pro tem.*

BOSTON, April 15, 1914. — A regular meeting of the Boston Society of Civil Engineers was held this evening at 7.50 o'clock, in Chipman Hall, Tremont Temple, President Harrison P. Eddy in the chair. There were 115 members and visitors present.

In the absence of the Secretary, on motion of Mr. Wason, Mr. J. E. Carty was elected Secretary *pro tem.*

The reading of the records of the annual meeting and of the special meeting of March 25, 1914, was by vote dispensed with, and the record of the annual meeting approved as printed in the April number of the JOURNAL.

The Secretary *pro tem.* announced the election by the Board of Government of the following new members in the grades named:

Members — Arthur Lassell Shaw and Clarence McLellan Weston.

Juniors — George Robert Burnes, Lyle Merton Richardson and Stanley Ward Woodbury.

Announcement was made of the following committees appointed by the Board of Government:

On Excursions — Leonard C. Wason, Bertram Brewer, Leonard L. Street, George A. Sampson.

On the Library — S. Everett Tinkham, Henry F. Bryant, Frederic I. Winslow.

On Publication — Joseph R. Worcester, Richard K. Hale, Arthur T. Safford.

On Membership — F. H. Fay, chairman; H. S. Adams, G. A. Carpenter, J. E. Carty, H. N. Cheney, L. S. Cowles, R. E. Curtis, A. W. Dean, C. R. Gow, F. M. Gunby, E. S. Larned, L. B. Manley, I. E. Moulthrop, J. F. Osborn, E. E. Pettee, E. H. Rockwell, W. H. Sawyer, C. M. Spofford, L. L. Street, David Sutton.

The death of Albert H. Howland, a member of the Society, which occurred on April 5, 1914, was announced by the President, and on motion of Mr. Fay the President was requested to appoint a committee to prepare a memoir. He has appointed as this committee Messrs. Frederick Brooks and Frank L. Fuller.

Mr. Fay offered an amendment, as printed in the notice of the meeting, to By-Law 9, so that, if said amendment were adopted, the By-Law would read: Permanent Fund. — There shall be a fund called the Permanent Fund, to which shall be added all money received for entrance fees and all income from investments of the fund, *provided, however, that the income of the the fund, or any portion thereof, in any year may be used for current expenses of that year, at the discretion of the Board of Government.* No money, *other than income above specified*, shall be appropriated from the fund except by a two-thirds vote at two successive regular meetings. Any such appropriation or any part thereof not used within three years shall be returned to the fund.

An animated discussion took place, which lasted until the President, in accordance with the By-Laws, postponed the discussion until after the literary exercises. After the conclusion of the literary exercises, the subject was opened again for discussion. A rising vote was then taken on the adoption of the amendment, 17 voting in favor and 14 against. The President thereupon declared the amendment lost.

Prof. C. Frank Allen moved that the Board of Government be authorized to use an appropriation from the Permanent Fund equivalent to the amount of the entrance fees for the fiscal year of 1913 and for the fiscal year of 1914. The motion

was seconded by Professor Sanborn. After a thorough discussion, a rising vote was taken, 25 voting in favor of the motion and 5 against. The President declared the motion carried and stated that it would come up for action again at the next meeting of the Society.

At the beginning of the literary exercises, the President welcomed the members of the Massachusetts Highway Association, and then introduced as the speaker of the evening, Mr. J. S. Miller, Jr., assistant chief chemist of the Barber Asphalt Paving Company, who gave an interesting lecture, illustrated with motion pictures, entitled "Asphalt and Asphaltic Street and Road Construction." A number of questions were asked the speaker, showing the interest taken in the lecture.

The meeting was adjourned at 10.30 o'clock.

JOHN E. CARTY, *Secretary pro tem.*

APPLICATIONS FOR MEMBERSHIP.

[May 1, 1914.]

THE By-Laws provide that the Board of Government shall consider applications for membership with reference to the eligibility of each candidate for admission and shall determine the proper grade of membership to which he is entitled.

The Board must depend largely upon the members of the Society for the information which will enable it to arrive at a just conclusion. Every member is therefore urged to communicate promptly any facts in relation to the personal character or professional reputation and experience of the candidates which will assist the Board in its consideration. Communications relating to applicants are considered by the Board as strictly confidential.

The fact that applicants give the names of certain members as reference does not necessarily mean that such members endorse the candidate.

The Board of Government will not consider applications until the expiration of twenty (20) days from the date given.

ACKERMAN, ALEXANDER SEYMOUR, Sandwich, Mass. (Age 34, b. Newburyport, Mass.) Student at Mass. Inst. of Technology for two and one-half years, Class of 1903. From June to September, 1901, sewer inspector, Newburyport; October, 1901, with J. P. Titcomb on surveys; November, 1901, to July, 1904, cartographer, Naval War College, Newport, R. I.; April and May, 1905, draftsman with C. H. Davis, So. Yarmouth; June, 1905, with Engrg. Corps as inspector of breakwater repairs; July to October, 1905, rodman and instrumentman with Engrg. Corps, Penn. Lines west of Pittsburgh; October, 1905, to September, 1907, with Division of Municipal Engrg., I. C. C., as rodman, levelman and transitman, on sewers, roads and water works; September, 1907, to date, with Cape Cod Construction Co. as asst. engineer, division engineer and senior asst. engineer. Refers to H. W. Durham, F. W. Hodgdon, A. J. Ober, J. W. Rollins and W. F. Williams.

BURPEE, GEORGE WILLIAM, New York, N. Y. (Age 30, b. Sheffield, New Brunswick.) Graduate of Bowdoin College, degree of A.B., 1904; graduate of Mass. Inst. of Technology, degree of S.B., 1906. During summer vacations, 1900 to 1903 inclusive, with Bangor & Aroostook R. R. in various subordinate positions on engineering staff; from June to September inclusive, 1905, chainman and rodman with maintenance of way department, Atchison, Topeka & Santa Fé R. R.; from June, 1906, to January, 1907, in office of chief engineer, Louisville & Nashville R. R.; from February, 1907, to June, 1911, with Westinghouse, Church, Kerr & Co., as field engineer on construction of power house and transmission line for Edison Electric Light Co., Brockton, Mass.; on valuation of electric properties for N. Y., N. H. & H. R. R.; assistant superintendent of construction on power house for Worcester, Mass., Electric Light Co.; also miscellaneous field and office work; from July to December, 1911, resident engineer, Canadian Northern Ontario Ry.; from January, 1912, to date, with Westinghouse, Church, Kerr & Co., chiefly engaged in investigations of engineering projects, more especially those relating to railways. Refers to C. F. Allen, E. J. Beugler, R. D. Bradbury, Moses Burpee, J. H. O'Brien, G. F. Swain and L. W. Tucker.

ELLIS, LESTER FISHER, Winter Hill, Mass. (Age 28, b. Woonsocket, R. I.) Graduate of Tufts College Engineering School, 1909. From 1909 to date, period of four and three-quarters years, with J. R. Worcester & Co. Refers to J. W. Ellis, C. R. Gow, E. A. Norwood, E. E. Pettee, H. B. Pratt, and Gilbert Small.

ENEBUSKE, CARL CLAËSSON, Cambridge, Mass. (Age 25, b. New York, N. Y.) Educated in private schools in Newton, and in Paris, France; 1904 to 1908, student in scientific course at Lycée Janson-de-Sailly, Paris, France. From October, 1908, to date, draftsman with J. R. Worcester & Co. Elected a Junior, March 20, 1912, and now desires to be transferred to grade of Member. Refers to G. H. Brazer, C. H. Dutton, E. E. Pettee and J. R. Worcester.

FRENCH, CHARLES AUGUSTUS, Laconia, N. H. (Age 42, b. Springfield,

Mass.) Graduate of Dartmouth College, 1893, degree of B.S. In 1893, with Board of Survey, City of Boston; 1894, with Sewer Department, City of Malden; from 1895 to 1901, with Metropolitan Water Board; from 1901 to 1906, Superintendent of Streets and Sewers, Marlboro, Mass.; from 1906 to present time, City Engineer, Laconia, N. H. Refers to M. A. Brown, F. H. Fay, W. B. Howe, E. S. Larned, W. H. G. Mann and J. W. Storrs.

GRAY, HOWARD ALLISON, Somerville, Mass. (Age 25, b. Somerville, Mass.) Educated in Somerville public schools and at Tufts College, from which institution he received degree of B.S. in Structural Engineering in June, 1911. With New England Structural Co. in template shop during summer months of college course; from June, 1911, to April, 1912, with same company in drawing office; April, 1912, to date, with Edison Electric Illuminating Co. of Boston, on drafting specifications, design of building construction and alterations, and checking of drawings. Refers to R. E. Curtis, I. E. Moulthrop, T. E. Penard, E. H. Rockwell, F. B. Sanborn and J. P. Snow.

MEAD, ROYAL LEE, Boston, Mass. (Age 30, b. Livingston, Mont.) Received high school education at Virginia City, Mont., and Northfield, Vt.; student for two years at Norwich University in Civil Engineering course. From April to September, 1910, rodman and instrumentman with C. A. Thayer, Providence, R. I.; September, 1910, to March, 1913, rodman and instrumentman with Boston Elevated Street Railway Co.; March, 1913, to April, 1914, draftsman in Engineering Department of Directors of Port of Boston; April, 1914, to date, steel designer and structural draftsman with Stone & Webster Engrg. Corp'n. Refers to J. F. Connell, H. R. Draper, C. T. Fernald and Daniel Scouler.

MILTON, SAMUEL LAWRENCE, Roxbury, Mass. (Age 28, b. Boston, Mass.) Student at Harvard University, 1905-08, mining and civil engineering courses; at Colorado School of Mines, 1908-09 (first semester); one year, evenings, with private consulting engineer, in reinforced concrete design work; one half-year, 1912, at Lowell Institute, for industrial foreman in electrical engineering course. From January, 1909, to February, 1911, with B. & A. R. R. in following positions: Instrumentman on station surveys, etc., inspector on new passenger station at Worcester, Mass., inspector and draftsman on new bridges in western Massachusetts, steam power station at Springfield, Mass., third tracking and State line tunnel; from March to August, 1911, with E. L. Ransome on design and construction of United Shoe Machinery buildings at Beverly, Mass.; from August to December, 1911, with Lockwood-Greene Co., on mill buildings, industrial plants, etc.; from January, 1912, to date, with Stone & Webster Engrg. Corp'n in following positions: Structural steel and reinforced concrete draftsman, hydraulic designer, efficiency supervisor, and (September, 1913, to date) engineer in charge of tests on new Mass. Inst. of Technology buildings at Cambridge; summer of 1906 at Harvard engineering camp; summer of 1907, at mining camp, Leadville, Colo.; summer of 1908, at mining camp, Bisbee, Ariz. Refers to H. K. Alden, Mark Linenthal, C. T. Main, L. G. Morphy and F. J. Wood.

ROBINSON, ASHLEY QUINCY, Attleboro, Mass. (Age 20, b. Webster, Mass.) Graduate of grammar school, Ware, Mass.; studied with father, Charles F. Robinson, C.E., Attleboro, Mass. From 1908 to 1912, rodman and transitman with C. F. Robinson, Attleboro, Mass.; from 1912 to June, 1913, inspector on sewer construction with J. J. Van Valkenburgh, C.E.; from August, 1913, to date, inspector on sewer construction with Metcalf & Eddy, Boston. Refers to H. P. Eddy, J. A. McKenna, F. A. Marston, J. J. Van Valkenburgh and J. P. Wentworth.

STORRS, EDWARD DOW, Concord, N. H. (Age 28, b. Concord, N. H.) Student at Dartmouth College in 1904; studied designing under John W. Storrs during winter of 1907-08. From spring of 1905 to spring of 1907, with engineering department of B. & M. R. R., first as rodman on general surveying work, later as bridge inspector; with Empire Bridge Co., Elmira, N. Y., as draftsman on detailing of bridge work, during part of 1907; engineer in charge of Connecticut River bridge at Claremont, N. H., summer of 1908; designed steel bridge over Merrimac River at Hooksett, N. H., 1909; steel bridge over Pemigewasset River at Hill, N. H., 1913; and numerous shorter spans, including bridges for towns of Wentworth, Tilton, Shelburne and Pembroke, N. H.; now junior member of firm of Storrs & Storrs, Bridge Engrs., Concord, N. H. Refers to W. B. Howe, F. W. Lang, W. H. G. Mann, J. P. Snow, J. W. Storrs and L. J. Wertheim.

TAYLOR, GEORGE, Wollaston, Mass. (Age 38, b. Athens, Ont.) Graduate of Athens High School, 1893; taught school three years; graduated from Brockville Business College, 1897; taught in College one year. From 1898 to date, with Eastern Expanded Metal Co., during past nine years as General Manager; familiar with different kinds of construction, especially that of concrete, plain and reinforced. Refers to C. R. Gow, E. F. Rockwood, L. L. Street and W. O. Wellington.

WILLIAMS, ALEXANDER KILPATRICK, Boston, Mass. (Age 32, b. Boston, Mass.) Graduated from Mechanic Arts High School, and took two years' course in steel and concrete designing at Boston Y. M. C. A. In 1899 entered the employ of C. A. Dodge & Co., General Contractors; worked on construction of buildings for three years, entered the office as estimator, became stockholder and director in 1908; has entire charge of estimating and detailing of reinforced concrete work on all work under contract. Refers to Joseph Driscoll, C. R. Gow, L. G. Morphy, L. L. Street and W. O. Wellington.

EMPLOYMENT BUREAU.

THE Board of Government has established an employment bureau for the Society, to be a medium for securing positions for its members and applicants for membership, and also for

furnishing employees to members and others desiring men capable of filling responsible positions.

At the Society room two lists are kept on file, one of *positions available* and the other of *men available*, giving in each case detailed information in relation thereto.

MEN AVAILABLE.

193. Age 26. Graduate of Mass. Inst. of Technology, Civil Engineering Course, 1910, degree of B.S. Experience includes work as rodman with Charles River Basin Comm. and Boston Elevated Railway Co.; transitman on pipe line and concrete drain construction with Metropolitan Water & Sewerage Board; draftsman with Fore River Shipbuilding Co., on survey and map of entire plant; transitman and chief of party on electric and steam railroad location, construction and maintenance; was for more than a year principal assistant to resident engineer for Worcester Consolidated St. Ry. lines; from August to December, 1913, was resident engineer on construction of Portland, Gray & Lewiston R. R.; is now in private practice as civil engineer and surveyor. For position desired and minimum salary expected please interview at office.

199. Age 23. Graduate of New Britain, Conn., High School; student for one year at University of Maine. Has had two years' experience as rodman and transitman with engineering department of city of Newton, and three months' experience as general assistant with local engineer. Desires position as transitman or sewer inspector. Salary desired, \$15 per week.

228. Age 45. Graduate of Mass. Inst. of Technology, degree of B.S. Experience includes five years on railroad construction; eight years as division engineer, principal assistant and chief engineer on sewer construction; fifteen months with National Board of Fire Underwriters on investigations and reports on fire protection of large cities of U. S.; five years in charge of surveys and construction, Reservoir Dept., City of New York; and more than two years on steel tower transmission line construction, Keokuk to St. Louis and in California. Will consider any reasonable position and salary for which experience qualifies him.

229. Age 28. Student for one year at Dartmouth College; has taken special courses in railroad and reinforced concrete engineering. Experience includes three years with Metropolitan Park Comm. of Boston as rodman, transitman and chief of party; five years on railway and general construction work in Cuba and Porto Rico; and two years with Porto Rico Construction Co. as resident engineer on construction of Ambursen dam at Comerio Falls. Desires position as engineer on construction. Salary desired, \$125 per month.

230. Age 25. Has had equivalent of two years of university work. Has had five years of good practical experience on city, land, railway, and

hydro-surveys, and construction; also office work connected therewith. Desires position as instrumentman, recorder or inspector, with contractor or firm of engineers and constructors. Salary desired, \$75 per month.

231. Age 26. Possesses liberal literary and commercial education. Has had nearly nine years of excellent clerical experience in Mechanical, Purchasing, Passenger, Legal and Engineering Departments of eastern and southern railways, including several months with B. & M. R. R., Boston; two years' work in connection with South Station Ticket Office, Boston; and five years with Florida East Coast Railway Co., on Key West Extension; still holds position with this Company as chief clerk of office, in charge of clerical force of five, work including supervision of all routine, preparation of various reports, statements, etc., employment and assignment of workmen, checking of payrolls, handling of considerable correspondence, and transcription of estimates and survey notes, as well as numerous other papers such as issue from an important engineering office; is conversant with ordering, checking and handling of railway, mechanical, subsistence and miscellaneous supplies. Desires clerical position in office of consulting or constructing engineer or contractor, in vicinity of Boston.

LIST OF MEMBERS.

ADDITIONS.

LANGLEY, MILES E.....	127 M St., South Boston, Mass.
RICHARDSON, LYLE M.....	237 Beacon St., Boston, Mass.
SHAW, ARTHUR L.....	6 Beacon St., Room 809, Boston, Mass.
WESTON, CLARENCE M.....	200 Fifth Ave., Room 1303, New York, N. Y.
WIGHT, WILLARD W.....	Wellesley Hills, Mass.

CHANGES OF ADDRESS.

BARNES, T. HOWARD.....	Room 1627, 17 Battery Pl., New York, N. Y.
BIGELOW, WILLIAM W.....	624 State St., Springfield, Mass.
BLISS, HERMON R.....	35 Boylston Ave., Providence, R. I.
BRADBURY, EDWARD C.....	Commercial Bldg., Columbus, Ohio.
BRUNEL, RICHARD	Care of J. R. Worcester & Co., 550 Masonic Bldg., Portland, Me.
COBB, WILLIAM A.....	Wilson's Mills, Me.
CRAIB, CHARLES G.....	2183 Hutchison St., Montreal, P. Q.
DRAPER, HARRY R.....	Box 143, Ayer, Mass.
DURHAM, HENRY W.....	Manhattan Municipal Bldg., New York, N. Y.
FRENCH, HERMAN W.....	Town Hall, Brookline, Mass.
GOULD, GARDNER S.....	551 E. Summit St., Kent, Ohio.
HARTWELL, DAVID A.....	745 Main St., Fitchburg, Mass.
LAVALLE, ALBERT H.....	274 Main St., Springfield, Mass.

PROCEEDINGS.

11*

LEE, EDWARD G. 83 Highland St., Woodfords Sta., Portland, Me.
 LINK, J. WILLIAM 206 S. La Salle St., Suite 1900, Chicago, Ill.
 MCKENZIE, WALTER S. 54 Upland Rd., Quincy, Mass.
 MAIN, CHARLES R. P. O. Box 1004, Great Falls, Mont.
 MALLEY, PATRICK J. 65 City Hall, Boston, Mass.
 PARLIN, RAYMOND W.

Care of Bureau of Municipal Research, 261 Broadway, New York, N. Y.

PRATT, DANIEL W. 33 Wildwood St., Winchester, Mass.
 RICH, MALCOLM Ferndale Rd., Wollaston, Mass.
 SHUTE, GEORGE P. City Hall, Portsmouth, Ohio.
 SKINNER, FENWICK F. 132 Lincoln Pl., Brooklyn, N. Y.
 SMITH, CHESTER W. 2 Rector St., New York, N. Y.
 SMITH, SIDNEY 255 Walnut St., West Lynn, Mass.
 SNOW, FRANKLIN A. 79 Milk St., Boston, Mass.
 STRADLING, DAVID W. 1932 Central Ave., Indianapolis, Ind.
 THORPE, GEORGE H. 107 Merrimack St., Lowell, Mass.

DIED.

HOWLAND, ALBERT H. Died April 5, 1914.

LIBRARY NOTES.

RECENT ADDITIONS TO THE LIBRARY.

U. S. Government Reports.

Balsam Fir. Raphael Zon.

Cretaceous Deposits of Eastern Gulf Region. Lloyd
 William Stephenson.

Douglas Oil and Gas Field, Converse County, Wyoming.

V. H. Barnett.

Geology of Long Island, New York. Myron L. Fuller.

Ground Water for Irrigation in Vicinity of Wichita, Kan-
 sas. O. E. Meinzer.

Lumber, Lath, and Shingles, 1912.

Magnetic Observations made by U. S. Coast and Geodetic
 Survey, July 1, 1911, to December 31, 1912. R. L. Faris.

Magnetic Observations made at U. S. Coast and Geodetic
 Survey Observatory at Sitka, Alaska, 1911 and 1912. Daniel
 L. Hazard.

Mineral Resources of U. S. for 1912. 2 vols.

Spirit Leveling in Kentucky, 1898 to 1913, inclusive. R. B. Marshall.

Spirit Leveling in Wyoming, 1896 to 1912, inclusive. R. B. Marshall.

Tests of Wooden Barrels. J. A. Newlin.

State Reports.

Massachusetts. Annual Report of Directors of Port of Boston for 1913.

Massachusetts. Special Report of Merrimac Valley Waterway Board, January, 1914. Gift of E. C. Sherman.

Massachusetts. Statutes Relating to Savings Banks.

New York. Regulation of Public Service Companies in Great Britain. Robert H. Whitten.

City and Town Reports.

Baltimore, Md. Annual Reports of Sewerage Commission for 1907-12, inclusive.

Belmont, Mass. Annual Report of Water Commissioners for 1913. Gift of C. W. Sherman.

Brookline, Mass. Annual Report of Water Board for 1913.

Clinton, Mass. Annual Report of Water Commissioners for 1913.

Concord, Mass. Annual Report of Board of Health for 1913.

Concord, Mass. Annual Report of Road Commissioners for 1913.

Concord, Mass. Annual Report of Water and Sewer Commissioners for 1913.

Haverhill, Mass. Annual Report of Water Commissioners for 1913.

Leominster, Mass. Annual Report of Water Board for 1913.

Medford, Mass. Annual Report of Water and Sewer Commissioners for 1913.

New Bedford, Mass. Annual Report of Engineering Department for 1913.

New Bedford, Mass. Annual Report of Water Board for 1913.

New York, N. Y. Preliminary Reports on Sewage Disposal, XV and XVI.

Plymouth, Mass. Annual Report of Water Commissioners for 1913.

Taunton, Mass. Annual Report of Water Board for 1913.

Woonsocket, R. I. Annual Report of Water Commissioners for 1913.

Miscellaneous.

American Hoist & Derrick Co. Catalog No. 106, 1914.

Life of J. Glancy Jones, 2 vols. Charles Henry Jones.

Municipal and Government Ice Plants in the U. S. and Other Countries. Jeanie Wells Wentworth.

LIBRARY COMMITTEE.

NEW ENGINEERING WORK.

(Under this head a brief description of new engineering work contemplated or under construction will be presented each month. Engineers and contractors are requested to send descriptions of their work to the Secretary, 715 Tremont Temple, Boston, before the 25th of each month.)

United States Government. — NAVY DEPARTMENT. — *Navy Yard, Boston.* — Work is now in progress or new work is contemplated as follows:

WORK IN PROGRESS.

Mold loft floor for new supply ship.

Timber wharf extension at Naval Magazine, Hingham.

Reconstruction of Building No. 24: reinforced concrete.

Remodeling Building No. 77 for use as boat storage, including equipment with crane service.

Two 300-ft. radio towers on Naval Hospital Reservation, Chelsea. (Contract let.)

Building for central heating plant, Naval Hospital, Chelsea, to be built by day labor.

NEW WORK CONTEMPLATED.

Fireproof floor, sprinkler system and metal storage racks, pattern shop, Building No. 42.

Building ways for construction of new supply ship.

Commonwealth of Massachusetts. — **METROPOLITAN PARK COMMISSION.** — *Woburn Parkway.* — Work of construction of parkway from Pleasant St., Woburn, to Pond St., Winchester, is in progress.

Charles River Reservation, Lower Basin. — Work of constructing wall in Broad Canal and granolithic walks on the Embankment, between Cambridge Bridge and Beacon Street, is in progress.

Charles River Reservation, Upper Division. The work in progress consists of surfacing and paving the Anderson Bridge and approaches and of dredging upper portions of the basin from North Beacon St. to Watertown.

Nahant Beach Parkway. — Work of construction of wooden bulkhead in Lynn Harbor is in progress.

Nantasket Beach Reservation. — Work of construction of radial brick chimney 100 ft. high by 4 ft. 6 in. inside diameter, and a garbage and refuse destructor, is in progress.

METROPOLITAN WATER AND SEWERAGE BOARD. — *Sewerage Works.* — Work in Section 69, new Mystic Sewer, at Winchester, is in progress. Section 57A, in Chelsea and Revere, will be let soon.

Boston Transit Commission. — *Boylston Street Subway.* — The Boylston Street Subway extends from Kenmore St. near the intersection of Commonwealth Ave. and Beacon St. to the southwest corner of the Common near Park Square, a distance of about 8 000 ft. It is completed except for a small portion of the Massachusetts Ave. station, the stairways to the Copley Square station, the interior finish of the stations, and the connection with the Tremont St. Subway near Park Square. Work is in progress in all of these places. The Boston El. Ry. Co. is installing tracks, duct lines, lighting conduits, etc.

Dorchester Tunnel. — Section B includes the station in

Summer St., which will extend from near Washington St. east to Arch St. Most of the roof is in place and the earth core below is excavated. The invert, platforms and center wall are being put in, and work is progressing at the junction of the new station with the Summer station of the Washington St. Tunnel. New manholes, pipes and conduits are being laid over the roof in advance of the backfilling.

Section C is located in Summer St., and extends from near Arch St. to Dewey Square, a distance of about 1 018 lin. ft. About two thirds of its length is to be built by tunneling, working from several shafts. The structure is to be mainly of reinforced concrete. Work is in progress in the open-cut section between Otis and Devonshire Sts., also in the side drifts of the tunnel.

East Boston Tunnel Extension. — Section G extends in Court St. from Court Square westerly to Stoddard St. The structural work is practically completed. The construction of a part of the station under and east of the present Scollay Square station is in progress. Isaac Blair & Company, Inc., is the contractor.

Section H is located in and near Court and Cambridge Sts., extends from Stoddard St. to Staniford St. and includes the Bowdoin Square station. The buildings on Cambridge St. adjacent to the work are being underpinned and portions of the side walls of the tunnel have been built. Excavation in Court and Green Sts. is under way. An outlet sewer in Chardon St. is about completed.

Section J extends from Staniford St. to North Russell St. The incline in Cambridge St. has been built. Construction work between Staniford and Chambers Sts. is in progress. The walls of the tunnel have been built, most of the roof has been placed and the invert is being put in.

City of Boston. — PUBLIC WORKS DEPARTMENT, HIGHWAY DIVISION, PAVING SERVICE. — Work is in progress on the following streets:

Cottage and Lubec Sts., from Gove St. to Porter St. Tar macadam.
Myrick St., from Coolidge Rd. to Easton St. Tar macadam.
Montebello Rd., from Washington St. to Brookside Ave. Tar macadam.

Park Lane St., from Park Lane to Olmstead St. Fence.
 Porter St., from Bismarck St. to Amory St. Tar macadam.
 Rexhame St., from Belgrade to Colberg Ave. Asphalt macadam.
 Spring St., from Webster St. to the Charles River. Asphalt macadam.
 Ballou Ave., from Willowwood St. to Woodrow Ave. Asphalt macadam.
 Colonial Ave., from Talbot Ave. to New England Ave. Asphalt macadam.
 Norfolk St., from Washington St. to the R. R. Bridge. Bitulithic.
 Vassar St., from Washington St. to Kilton St. Tar macadam.
 Wellington Hill St., from Blue Hill Ave. to Morton St. Asphalt macadam.
 River St., Mattapan Square to the Hyde Park line. Tar macadam.
 Binney St., from Longwood Ave. to Francis St. Asphalt macadam.
 Roach St., from Dorchester Ave. to Pleasant St. Artificial stone.
 St. Luke's Rd., from Brighton Ave. to Commonwealth Ave. Tar macadam.

New York, New Haven & Hartford Railroad. — Clinton, Mass. Elimination of Grade Crossings. Work on the Boston & Maine Railroad now in progress is the building of a passenger station.

Work on the N. Y., N. H. & H. R. R. now in progress is the building of a reinforced concrete arch at Main St. and the grading and excavation of Water and High Sts., and the work in connection with the drainage of the same. The steel bridge for the tracks across those of the B. & M. R. R. is in process of erection.

The Fore River Shipbuilding Co., Quincy, Mass., has the following new work in progress:

U. S. Battleship *Nevada*.

U. S. Submarine Tender *Fulton*.

Nine U. S. Submarine boats.

U. S. Torpedo Boat Destroyers *Cushing* and *Tucker*.

General Cargo Steamers *Atlantic* and *Pacific*.

BOSTON SOCIETY OF CIVIL ENGINEERS
FOUNDED 1848

PAPERS AND DISCUSSIONS

This Society is not responsible for any statement made or opinion expressed in its publications

REPORT OF COMMITTEE ON SEWERAGE STATISTICS.

BOSTON, MASS., March 4, 1914.

SANITARY SECTION, BOSTON SOCIETY OF CIVIL ENGINEERS,
BOSTON, MASS.:

Gentlemen,—Your Committee on Sewerage Statistics appointed in accordance with the vote of the Section on December 3, 1913, “. . . to report . . . on the advisability of continuing the collection and tabulation of sewerage statistics by the Section, and the form of blank to be recommended . . .”; begs leave to report as follows:

It may assist in a clearer understanding of the present status of this question, briefly to review the work of previous committees and the conclusions reached by them.

At the first annual meeting of the Sanitary Section, held March 2, 1904, it was voted “that a committee of five be appointed by the chair to consider the subject of ‘Uniform Statistics of Sewer Maintenance,’” and the following were appointed to serve on that committee: Bertram Brewer, W. D. Hunter, Irving T. Farnum, W. D. Hubbard, H. P. Eddy.

The report of that committee was presented on March 7, 1906, and the form recommended for the presentation of sewerage statistics, with which you are familiar was adopted by the Section on June 9, 1906.

NOTE. Discussion of this paper is invited, to be received by Edward C. Sherman, Editor, 6 Beacon Street, Boston, by August 15, 1914, for publication in a subsequent number of the JOURNAL.

At the annual meeting of the Section on March 4, 1908, a "Committee on Collection and Tabulation of Sewerage Statistics" was appointed, consisting of Harrison P. Eddy, Charles Saville and Bertram Brewer. That committee presented a report, dated May 8, 1908, including tabulations of statistics relating to sewerage and sewage disposal, secured from twenty-four municipalities for the year 1906. That report was subsequently printed in the *Journal of the Association of Engineering Societies*, Vol. XL, No. 5, for May, 1908.

On February 3, 1909, the same committee presented a report embodying tabulations of sewerage statistics collected from forty-eight municipalities for the year 1907. That report was published in the *Journal of the Association of Engineering Societies*, Vol. XLII, No. 3, for March, 1909. Those tabulations included more or less complete reports from twenty-five cities and towns in Massachusetts, four in New York state, two each in New Hampshire, Rhode Island, Pennsylvania and Utah, and one each in Connecticut, New Jersey, Ohio, Indiana, Illinois, Michigan, Colorado, Kentucky, Minnesota, Washington and the Dominion of Canada, — a total of forty-eight municipalities, thirty-three having a population of over thirty thousand.

The collection and tabulation of those statistics involved a large amount of work, and the Society is greatly indebted to the members of that committee for bringing together a vast amount of useful information. The final report of the same committee was made on March 6, 1912. In that report, the committee stated as follows:

"The form of statistics adopted by the Section has been adopted by several city officials and embodied in their annual reports. The committee feels that this forms a valuable part of the reports, and that its use should be encouraged. To this end your committee recommends that the printed blanks in its possession be turned over to the secretary of the Section, and that he be requested to make reasonable effort to have city officials interested in this line of work adopt this form and embody it in their annual reports.

"The committee is of the opinion that it is unnecessary for the present to continue the collecting and compiling of sewer-

age statistics, as was done for one or two years, and suggests that the committee be now discontinued."

Apparently, one of the objects sought by the original committee was to induce the Bureau of the Census to accept the form recommended by the Section for the publication of sewerage statistics, which the Census Bureau had already undertaken in a small way. In the annual report of the Executive Committee of the Sanitary Section, March 6, 1907, is given a copy of a letter written to Mr. M. N. Baker by LeGrand Powers, chief statistician of the Bureau of the Census, Washington, D. C., February 23, 1907, in which Mr. Powers makes the following statement:

" . . . it seems to me that the true position of the census with reference to the schedule of the Boston Society of Civil Engineers is as follows: The Census Office accepts that schedule tentatively as a basis of future work, and will proceed to make use of the same in the collection of data for its statistical publications so soon as a sufficient number of cities, through their engineering department, adopt that schedule in recording data. . . . "

Last year the Department of Commerce, Bureau of the Census, William J. Harris, director, published a volume entitled, "Special Reports, General Statistics of Cities, 1909, including Statistics of Sewers and Sewage Disposal, Refuse Collection and Disposal, Street Cleaning, Dust Prevention, Highways, and the General Highway Service of Cities having a Population of over 30 000. Prepared under the Supervision of LeGrand Powers, Chief Statistician for Finance and Municipal Statistics," in connection with which eleven "general tables" are presented, embodying sewerage statistics collected from one hundred and fifty-eight cities of over 30 000 population for the year 1909. The data given in these tables are shown by the following headings for each table, taken from the report:

TABLE I.
SEWERS — GENERAL STATISTICS OF SEWER SYSTEMS. 1909.

CITY NUMBER.	CITY.	POPULATION.		Area (Acres) Served by Sewer System. (Estimate.)	MILEAGE OF SEWERS.						EXPENSES OF OPERATION AND MAINTENANCE.				CITY NUMBER.
		Total.	Served by Sewer System. (Estimate.)		Classified by Character.		Classified by Construction Material.			Total.	Per 1 000 Population Served.	Per Mile of Sewer.			
MILEAGE OF SEWERS. Classified by Construction Material. (Cont'd.)	Reinforced Concrete.	Vitrified Pipe.	Cement Pipe.	All Other.	NUMBER OF MANHOLES.		NUMBER OF IN- VERTED SIPHONS.		NUMBER OF STORM- WATER OVERFLOWS.	NUMBER OF OUT- LETS.	COST OF REPLACE- MENT VALUE OF SYSTEM.	EXPENSES OF OPERATION AND MAINTENANCE.			CITY NUMBER.
					Total.	Per Mile of Sewer.	NUMBER OF IN- VERTED SIPHONS.	NUMBER OF STORM- WATER OVERFLOWS.				NUMBER OF OUT- LETS.	Total.	Per 1 000 Population Served.	
MILEAGE OF SEWERS. Classified by Construction Material. (Cont'd.)	Reinforced Concrete.	Vitrified Pipe.	Cement Pipe.	All Other.	NUMBER OF MANHOLES.		NUMBER OF IN- VERTED SIPHONS.		NUMBER OF STORM- WATER OVERFLOWS.	NUMBER OF OUT- LETS.	COST OF REPLACE- MENT VALUE OF SYSTEM.	EXPENSES OF OPERATION AND MAINTENANCE.			CITY NUMBER.
					Total.	Per Mile of Sewer.	NUMBER OF IN- VERTED SIPHONS.	NUMBER OF STORM- WATER OVERFLOWS.				NUMBER OF OUT- LETS.	Total.	Per 1 000 Population Served.	

TABLE 2.
SEWERS — MILEAGE AT CLOSE OF YEAR, CLASSIFIED BY CHARACTER AND BY MATERIAL OF WHICH CONSTRUCTED, 1909.

CITY NUMBER.	CITY.	TOTAL.
		Sanitary.
		Total.
		Brick.
		Vitrified Pipe.
		All Other.
		Combined.
		Total.
		Brick.
		Concrete.
		Vitrified Pipe.
		All Other.
		Storm Water.
		Total.
		Brick.
		Concrete.
		Vitrified Pipe.
		All Other.

TABLE 3.
SEWERS—MILEAGE BUILT DURING YEAR. 1909.

CITY NUMBER.	CITY.	TOTAL.	CLASSIFIED BY CHARACTER.			CLASSIFIED BY BUILDER.											
			Sanitary.	Combined.	Storm Water.	City Employees.			Contractors.								
						Total.	Brick.	Concrete.	Reinforced Concrete.	Vitrified Pipe.	All Other.	Total.	Brick.	Concrete.	Reinforced Concrete.	Vitrified Pipe.	All Other.

TABLE 4.

SEWERS — EMPLOYEES AND EXPENSES OF OPERATION AND MAINTENANCE. 1909.

Part I. Cities having No City Employees Engaged on Sewer Construction Work.

Part II. Cities having City Employees Engaged on Sewer Construction Work.

CITY NUMBER.	CITY.	Total Mileage of Sewers.	Average Number of Employees.										Expenses of Operation and Maintenance.											
			All Classes.				Superintendents and Engineers.	Foremen and Inspectors.	Mechanics and Skilled Laborers.	Teamsters.	Unskilled Laborers.	All Others.	Total.	Per Mile of Sewer.	Per 1 000 Population Served.									
			Total.	Per Mile of Sewer.	Per 1 000 Population Served.																			

TABLE 5.

SEWERS — HOUSE CONNECTIONS. 1909.

CITY NUMBER.	CITY.	TOTAL MILEAGE OF SEWERS.	HOUSE CONNECTIONS.							Size (Inches).	Number of Stoppages.
			At Close of Year.			Made during Year.					
			Number.	Length. (Miles).	Average Length. (feet).	Number.	Length. (feet).	Average Cost per Foot.			

TABLE 7.
SEWERS — DISCHARGE OF SEWAGE. 1909.

CITY NUMBER.	CITY.	VOLUME OF SEWAGE DISCHARGED.					STREAM OR BODY OF WATER INTO WHICH SEWAGE IS DISCHARGED.
		Estimate of Discharge Based on	Daily during Year. (Gallons.)				
			Average.	Maximum.	Minimum.	Average per Person Served.	

TABLE 8.
SEWERS — PUMPING OF SEWAGE. 1909.

CITY NUMBER.	CITY.	SEWAGE PUMPED DURING YEAR.				DAILY CAPACITY (OF PUMPS, GALLONS.)	AVERAGE STATIC HEAD AGAINST WHICH PUMPS WORK. (FEET.)	KIND OF POWER USED IN PUMPING.	AVERAGE NUMBER OF EMPLOYEES AT PUMPING STATION.	EXPENSES OF PUMPING STATION FOR YEAR.	
		Total Quantity of (Millions of Gallons)	Per Cent. of Total Discharge.	Million Gallons (average) per Day.	Employee at Pumping Station.					Total.	Per Million Gallons Raised 1 Ft.

TABLE 9.
SEWERS — SEWAGE PURIFICATION SYSTEMS 1909.

CITY NUMBER.	CITY.
AVERAGE DAILY QUANTITY (GALLONS) OF SEWAGE TREATED.	Total. Per Cent. of Total for City.
SEWER SYSTEMS FOR WHICH SEWAGE WAS PURIFIED.	SEWAGE PUMPED.
APPARATUS FOR PRELIMINARY PROCESS.	TANKS.
	Kind. Number.
FILTERS.	Kind. Number.
BODY OF WATER INTO WHICH DISCHARGED IS	

TABLE 10.
SEWERS—SEWAGE PURIFICATION IN TANKS. 1909.

[illegible]

TABLE II.
SEWERS — SEWAGE PURIFICATION IN FILTERS. 1909.

CITY NUMBER.	CITY.	KIND OF FILTERS.	DATE OF CONSTRUCTION.	NUMBER OF FILTERS.	AREA OF FILTERS. (ACRES.)	DEPTH OF FILTERING MATERIAL. (INCHES.)	DOSING.		QUANTITY (GALLONS) TREATED DAILY.			EXPENSES OF OPERATION.		
									Average.	Per Acre of Beds.	Maximum.			
		Hours per Dose.	Times per Month.							PER CENT. OF SUSPENDED SOLIDS REMOVED.				
								Total.	Per Million Gallons Treated.	Per Acre of Beds.				

REMARKS.

Tables 1, 2, 3, 4 (Parts I and II), 5, 6, 7 and 8 are arranged as follows:

- Group I. Cities having a population of 300 000 or over in 1909.
 Group II. Cities having a population of 100 000 to 300 000 in 1909.
 Group III. Cities having a population of 50 000 to 100 000 in 1909.
 Group IV. Cities having a population of 30 000 to 50 000 in 1909.
 Tables 9, 10 and 11 are not grouped.

A comparison of these headings with those on the form recommended by the Section shows that the ground has been pretty well covered by the census. Some of the subjects on the form prescribed by the Section, not included in the census tables, are dealt with in the text, as, for example,

- Methods of Financing the Construction Cost of Sewers.
- Ventilation of Sewers.
- Quantity of Factory Wastes.
- Kinds and Quantities of Chemicals used in the Treatment.
- Disposition of Sludge.

Concerning certain other subjects, information from a sufficient number of cities to tabulate could not be obtained apparently, such as,

- The Number of Buildings Connected with the Sewers.
- The Cost of Sewer Flushing.
- Cost of Removal of Catch-Basin Material.
- The Cost of Different Parts of the Treatment Works.
- The Water Capacity of Contact and Trickling Filters.

The principal items on the Boston Society of Civil Engineers standard form not covered by the Census Report are as follows:

- Total area city or town.
- Cost of flushing per mile.
- Cost of removing catch-basin material.
- Number of buildings connected.
- Leakage into sewers.
- Description of pumping plants.
- Description of fuels used, etc.
- Average dynamic head.
- Description of screens in connection with pumps.
- Cost of filters.
- Were loam and subsoil removed?
- Character of filtering material.
- System of underdrains.
- Dosing apparatus and size of dose.
- Method of caring for surface of filters.
- Cubic yards material removed from surface.
- Cost of removing same.
- Are crops raised, etc.?
- Amount received for crops.
- Water capacity of contact or trickling filters and decrease since plant was started.

In the main, it will be found that the subjects upon which the Census Bureau does not report are relatively unimportant. On the other hand, there are several interesting items not called for in the form of the Sanitary Section, which are included in the census statistics, the most important being the following:

- Classification of mileage of different types of construction built during the year by city employees and by contractors.
- Number of employees of different grades on operation and maintenance of sewer systems at pumping stations and at treatment works.
- Number of specially constructed wagons for grit chamber removal.
- The basis for the estimation of sewage flow.
- Daily capacity of pumps.
- Depth of filtering material.
- Number of sewer outlets.
- Night soil disposal.

The committee feels that great credit is due the Census Bureau for collecting these valuable sewerage data and presenting them in such usable form. The scope of their work is much greater than any committee of this Section could hope to cover. Further, the census report deals in a similar manner with such kindred sanitary subjects as refuse disposal, street cleaning, dust prevention and general highway service, as well as statistics of salaries and wages.

In view of these facts, your committee recommends that the efforts of the Section to collect and tabulate general sewerage statistics be abandoned and that the same energy be applied along lines of special inquiry, as they become of interest. For example, it might be appropriate at the present time to consider the construction, operation and efficiency of tanks of the Imhoff type or sprinkling filters.

The Census Bureau does not at present collect statistics from municipalities of less than 30 000 population. In this connection, it might be stated that the census limit of urban population, up to 1880, was 8 000. Later, this limit was reduced to 4 000 and for the last census (1910) it was 2 500. Reasoning from analogy, it is probable that before many years the statistical work of the Bureau will be extended so as to include municipalities of less than 30 000 population.

The importance of sewerage statistics appears to be appreciated by the Census Bureau, and the incompleteness and inaccuracy of their records are acknowledged and pointed out. It is fair to assume, therefore, that as the years go on the census statistics will widen in scope and increase in accuracy. We believe that the Boston Society of Civil Engineers should do all in its power to assist the Bureau of the Census to accomplish this result, and your committee would respectfully suggest that the services of this Section be tendered to the Census Bureau to that end.

In regard to the blank form to be recommended to municipalities for reporting their statistics, we can see no legitimate reason to advocate anything but the census forms, which apparently have been based on the form recommended by this Society hitherto.

Respectfully submitted,

(Signed) ALMON L. FALES,
EDWIN H. ROGERS,
GEORGE C. WHIPPLE,
Committee.

DISCUSSION.

GEORGE A. CARPENTER. — Under an article entitled, "A Brief Review of Recent Advances in Sewerage and Sewage Disposal," printed in *Engineering and Contracting* of February 25, 1914, a committee of the Illinois Society of Engineers reports as follows:

"This committee would urge upon all members of the Illinois Society of Engineers the endeavor to gather careful cost data, even though brief, and in particular to gather data on the cost of operation and maintenance of sewers and sewage pumping stations, wherever it may be within their power to do so. For the collection of such data and its report, a most useful form has been devised by the Sanitary Section of the Boston Society of Civil Engineers, which the members of this society could well follow, not alone for their private information, but for the use of the society as a whole and the service of the sewerage and sewage disposal committee in making up its annual statement. The committee urges that every member of the society who is responsible for the sewers of a community should endeavor to have his community make up its annual report along the lines of the standard form, and should endeavor to have these data in hand early enough for the use of the committee of this society each year. If this can be done, much useful information will be obtained of service not alone to the members of this society, but to all engineers interested in like pursuits."

BOSTON SOCIETY OF CIVIL ENGINEERS
FOUNDED 1848

PAPERS AND DISCUSSIONS

This Society is not responsible for any statement made or opinion expressed in its publications

THE COLLECTION AND TREATMENT OF SEWAGE IN
THEIR RELATION TO THE CITY OF PHILADELPHIA.

BY GEORGE S. WEBSTER, CHIEF ENGINEER.

(Presented before the Sanitary Section, March 4, 1914.)

SEWERAGE SYSTEM.

THE sewers of the city of Philadelphia as originally built discharged the crude sewage directly into the rivers and nearby streams, this not being considered objectionable at that time; but as the population increased and many tributary sewers were constructed, the smaller streams became seriously polluted and the Delaware and Schuylkill rivers, from which the city's water supply is taken, became so contaminated that in order to protect the public health it was necessary to take measures to alleviate the conditions.

The first work undertaken, commenced about the year 1883, was the construction of an intercepting sewer along the east bank of the Schuylkill River, from tidewater below Fairmount Dam to approximately the northern boundary of the city, with a main branch extending north along the Wissahickon Creek, thus keeping out of the water supply taken from the Schuylkill River all the sewage, collected in an extensive system of separate sewers, from Manayunk, Roxborough, Falls of

NOTE. Discussion of this paper is invited, to be received by Edward C. Sherman, Editor, 6 Beacon Street, Boston, before August 15, 1914, for publication in a subsequent number of the JOURNAL.

Schuylkill and the portions of Germantown and Chestnut Hill lying in the Wissahickon and Schuylkill watersheds within the city limits. Recently an intercepting sewer has been constructed along the east bank of Cobbs Creek, to collect the dry-weather flow and first flush of the rain discharged from the combined sewers into that stream, which had become so seriously polluted as to be objectionable to sight and smell; and within the past two years an intercepting sewer has been built along the Pennypack Creek, in the northeastern part of the city, to collect the sewage from the village of Holmesburg and from three large municipal institutions and convey it to treatment works, where it is purified sufficiently to protect the water supply taken from the Delaware River.

The city of Philadelphia has therefore what may be considered three systems of sewers: The combined system which covers by far the larger part of the city, the separate system which has been adopted in the areas adjacent to the portion of the Schuylkill River from which the water supply is taken, and the intercepting sewers along Cobbs Creek and Pennypack Creek.

The city is now engaged in the preparation of a comprehensive plan for the collection and treatment of its sewage, for submission to the state department of health, and the work which is now being constructed is in harmony with the plans which will be recommended. The investigations which have been carried on include a large number of studies of possible methods of collecting the sewage, the operation of a sewage experiment station, sanitary surveys of the water-courses and rivers, and the construction and operation of a plant to treat the sewage in one section of the city adjacent to the water supply. The magnitude of the problem will be appreciated when it is considered that the area of the city is 130 square miles, that it has a population of 1 650 000, and that the water consumption is approximately 200 gal. per capita daily; this, with the infiltrated ground-water from the older sewers, produces at the present time a large volume of sewage estimated at 400 000 000 gal. a day.

The problem of sewage disposal in Philadelphia is two-fold: first, to collect the sewage from the present system and

abolish the nuisance which now exists in the large creeks and lower Schuylkill owing to the insufficiency of diluting water, and to carry it to distant points for treatment; and second, the protection of the public health by the treatment of the sewage, which is now and in the future will be discharged into the Delaware River, this treatment to be carried to such a degree that the drinking water can be safely and economically purified before delivery to the consumer.

It is of great importance, in preparing designs both for the collecting system and the treatment works, that relief may be given from the present objectionable conditions in the shortest possible time, that the work may be carried on economically and advantageously from time to time as funds become available, that each step taken may give some relief, and that it will not be necessary for the completion of the entire project before benefits may be obtained.

It was found early in the investigations that the cost of installing the separate system in those parts of the city already sewered on the combined plan would be prohibitive, for in addition to the cost to the city of laying sewage pipes in every street, the plumbing fixtures in all buildings connected to the sewer system would have to be rearranged so that the sewage and the rainwater could be carried in separate conduits. This latter expense, which would amount to many millions of dollars, would have to be borne by the individual owners.

In the design of sewers for the purpose of carrying sewage only, the factors used are the contributing population, water consumption and the amount of infiltrated ground-water. It is quite common practice in many cities in designing sewage sewers to calculate that they shall run half full, when carrying a water consumption of 150 gal. per capita from the population tributary. To reach a conclusion as to the quantity of sewage to be treated by the city of Philadelphia in the future, and to obtain data for the design of the intercepting sewers, gagings were made of the dry-weather flow of a number of main sewers, some of which were located in solidly built-up areas and others in partly built-up districts, and from the factors thus obtained estimates were prepared, based upon the probable increase and

density of population, of the quantity of sewage that must be cared for in the future, the estimates and population curves being projected to the year 1950.

The amount of sewage flow determined by the gagings in all cases included the infiltrated ground-water, no practical way appearing by which it could be differentiated from the sewage proper. As a majority of the sewers in which gagings were taken are of considerable size and length, the variation between the maximum, minimum and average rates of flow is not as great as in smaller sewers. The mean of all the gagings showed that the maximum flow was 128 per cent. of the average, and the minimum 78 per cent. of the average.

In addition to the flow of sewage, it has been decided to admit into the intercepting sewers, through automatic regulators, the first flush of the rain, which is usually as polluting as sewage, and the amount to be admitted has been fixed at 10 per cent. of the maximum dry-weather flow of the sewers, but a much larger percentage can be intercepted when the sewage is not flowing at a maximum rate. This additional 10 per cent. makes a storm maximum flow of 141 per cent. of the average flow.

When it is considered that the per capita consumption of water in Philadelphia is 200 gal. a day and that in the towns of England only about 40 gal. is used, it will be seen that by the arrangement proposed the degree of dilution of the sewage, in time of storm, compares well with the English practice of treating six times the normal dry-weather flow.

In studying the methods of disposal it has been found that the sewage may be treated with much less offense if it reaches the works in a comparatively fresh state before putrefaction has set in, therefore great care is being taken in the design of the sewer system that the velocity of flow shall not be less than that required to carry the materials in suspension. This is accomplished by providing proper gradients and by the exercise of care to secure smooth surfaces, avoiding all roughness and projections on the interior of the sewer where organic matter might find lodgment and be retained until putrefaction sets in and stench begins. Upon examination of many of the sewers in Europe there was no odor noticeable because the interior

surfaces were smooth, either vitrified tile or smooth glazed brick being used, and all connections so made as to provide a natural flow without the creation of eddies where deposits might occur. It is, therefore, recognized that a solution of a part of the problem of sewage treatment is to construct sewers with smooth interiors and to keep them clean and inoffensive.

In designing the collecting system, it is proposed to construct intercepting sewers at two levels, and in this way to utilize the potential energy in every foot of head and carry to the treatment works by the high-level interceptors the greatest possible volume of sewage, and thus reduce to a minimum the quantity to be pumped.

The collecting systems in many European cities are constructed so as to convey the sewage to one or more suitable locations for treatment, and care is exercised in their designs to secure the greatest economies.

SANITARY SURVEYS.

There are in Philadelphia five large creeks and the Schuylkill River, all of which are tributary to the Delaware River, which forms the eastern boundary of the city. Poquessing Creek flows through a territory but little developed and is therefore not at the present time polluted. The sewage formerly discharged into Pennypack Creek and Wissahickon Creek has been intercepted and the water in these streams restored to a normal condition. A large part of the sewage on the Philadelphia side of Cobbs Creek has been intercepted and the condition of the water in this creek greatly improved. Frankford Creek, which empties into the Delaware River about five miles south of the Torresdale Water Filters, flows in part through a densely built up and industrial part of the city and receives crude sewage from about 140 000 people. It has several dams along its length and therefore low velocities. The water is not only grossly polluted by the discharge of sewage into it, but the deposits of sewage origin upon the bed of the creek add to the nuisance.

The Schuylkill River flows through the city in a generally

southerly direction, and about midway there is a dam which forms the end of tidal influence. The section of the river north of the dam has been protected within the city limits by intercepting sewers. Into the tidal portion of the river below the dam, however, there is now being discharged the sewage from about 455 000 people. At times of drought almost the entire upstream flow is used for water supply, leaving a very inadequate volume of diluting water for the sewage from this large population. The examinations made during the summer months showed the water in this part of the river to be depleted of dissolved oxygen. Furthermore, the tidal velocities in the lower part of the Schuylkill River are insufficient to maintain the sewage matter in suspension, so that in addition to the polluted condition of the water, the putrefying deposits upon the bed of the river increase the nuisance, particularly in warm weather; but as in the case of Frankford Creek, above described, the natural sedimentation processes and the gasification of the resulting sludge, together with the refreshing action of the tide, lighten the load of organic matter placed upon the waters of the Delaware River.

The Delaware is one of the large rivers of the United States, and forms the natural drainage for portions of the states of Pennsylvania, New York and New Jersey. The normal flow of upland water is at the rate of 4 050 sec.-ft., in addition to which there is a tidal range of $5\frac{1}{2}$ ft., and it is estimated that during the ebbing of the tide 2 421 000 000 cu. ft. of water flow past the city. As the sewage of the city at present and the effluent from the treatment works in the future must be disposed of in the waters of this river, its present condition has been examined with considerable care and it was found that with the exception of the docks, where sewers discharged, the Delaware River is successfully disposing of the crude sewage of the present population of Philadelphia in addition to that of the neighboring towns. Even in summer weather and in times of extreme drought, there has been no nuisance or offense created, although the amount of dissolved oxygen in the river has been small. The surveys indicated that the river water after passing beyond the points of discharge of the sewage of the

city gained rapidly in its oxygen content. The high velocities, due to tidal flow in the river, maintain the sewage matters in suspension, and the examination shows that the entire bed of the river (excepting the docks) is clean and free from deposits of sewage origin.

It must, however, be realized that, with the increase in the population and the consequent added load placed upon the river, its oxidizing power will soon be overtaxed and that the time to begin the building of the collecting and treatment works is at hand.

TREATMENT WORKS.

The sanitary surveys of the water-courses in Philadelphia show that sewage must be excluded from the creeks and the Schuylkill River, and that the treatment works must be located so as to discharge their effluents into the Delaware River in order to utilize to the fullest extent the great diluting and oxidizing capacity of that river.

It is proposed to locate the first treatment works in the northeast section of the city. The collecting system tributary thereto will eliminate the pollution of Frankford Creek and also prevent the discharge of crude sewage into the Delaware River within the tidal influence of the Torresdale Water Filters which provide three-fifths of the city's water supply. The degree of treatment required at this works must therefore be based upon a hygienic standard in order that the public health will not be jeopardized by overtaxing the economical and safe operation of the water filters.

The second treatment works will be located in the southwest part of the city, near the mouth of the Schuylkill River, the most distant point within the city limits from the source of water supply. The collecting system tributary to this works will eliminate the pollution of the lower Schuylkill River and will result in concentrating the sewage from over half the population of the city at one point for treatment. As the effluent of this works will be entirely below the influence of the city's water supply, the degree of treatment required need only be sufficient to prevent nuisance in the Delaware River.

It appears to be economical to construct temporarily a clarification works in the southeast district, to care for the sewage now discharged into the Delaware River below the center of the city.

TREATMENT.

In selecting methods for the disposal of the great volume of sewage produced in large cities, the adaptability of the various processes to a comprehensive plan must be considered so that the treatment works may be constructed by successive steps as needs arise for more refined treatment and as funds become available. It is desirable to obtain intensive methods, so as to secure a maximum of efficiency upon a minimum area of land, but in all cases exercising care to prevent nuisance from odors.

Various methods for the treatment of the sewage of the city of Philadelphia were studied, and those best adapted to the local conditions selected.

It has been frequently urged that the sewage of the city could be purified to advantage by applying it to farm land. Mr. John D. Watson, after years of experience, aptly states that this method of disposing of sewage "may be ideal in theory, but it is difficult, if not impossible, to obtain the ideal on a farm of large size." Berlin and Paris dispose of their sewage in this way, but, owing to the small volume of sewage which can be treated per acre, large areas of suitable land are required.

The Metropolitan Sewerage Commission of New York City has estimated that 175 square miles of land would be required to treat the sewage of that city if it were applied at the rate of 12 000 gal. per acre, and that the cost of this method of treatment would be \$153 000 000, and therefore dismissed it as being impracticable. The city of Birmingham, England, has abandoned its sewage farms and substituted the more intensive biological method, and the same course will probably be followed in Paris.

✶ To treat at the present time the sewage of Philadelphia on farm land would require an area of approximately 60 square miles. To secure this amount of land in Pennsylvania adjacent to the city would be prohibitive on account of the cost, and

would be opposed by citizens and property owners, hence this method of treatment need not be further considered.

London, the largest city in the world, with a population of 6 000 000 people, situated on the banks of a river with but little larger flow of upland water than the Schuylkill, disposes of its sewage by removing about 75 per cent. of the suspended matter by chemical precipitation and depends upon the oxidizing power of the river to accomplish its ultimate purification. That this is being successfully accomplished may be seen from the diagram which was prepared by Sir Maurice Fitzmaurice, late chief engineer of the London County Council, showing the percentage of saturation of the Thames River with dissolved oxygen, in connection with which he states, "With respect to the minimum amount of dissolved oxygen that should be present to prevent offense, it is rather difficult to answer this exactly, but I may say that the only complaint in recent years was for a short time in 1901."

While this method has been successfully used in London, it would not be applicable to Philadelphia, on account of the long haul to dispose of the sludge in the ocean, over one hundred miles distant. Another objection is the large quantity of sludge produced. From the best information available, it appears that the sludge, containing about 95 per cent. water, resulting from this method of treatment, amounts to 800 tons per day for a population of 500 000 people.

The city of Manchester, England, has probably the largest installation of contact beds. These are found to be expensive to operate and fail to produce an effluent up to the requirements of the Rivers Board. The concensus of opinion among experts in England seems to be that contact beds for a large installation are not as efficient as percolating filters.

From the results obtained at the Philadelphia Experiment Station and from the plant in operation at the Pennypack Creek, confirmed by the testimony of the city engineers who inspected a number of plants in Germany, it has been found that the two-story sedimentation tank, known as the Emscher tank, offers the best solution for the preliminary treatment of the sewage. The advantages are that the separation of the settling sewage

from the digesting sludge maintains the sewage in as fresh a condition as it enters the tank, that it is equal in efficiency to any other type of tank in removing the suspended matter with shorter retention periods and that the sludge withdrawn is without offensive odor, is smaller in volume than sludges resulting from other processes and more easily dried, and is so thoroughly decomposed that it resembles garden soil and may be used for filling in low lands without nuisance.

It is the purpose to recommend for the northeast and southwest treatment works the following processes in sequence: Coarse screens to restrain the large floating objects, grit chambers designed to intercept the inorganic matter only, two-story sedimentation tanks of the Emscher type, and percolating filters or such other improved methods of oxidation as may be developed by the time this refinement is needed. All of these processes are so related that they can be incorporated in the work successively; each one is the most intensive of its kind, therefore a minimum amount of land will be required for the works.

At the Southeast Works it is proposed temporarily to clarify the sewage either by fine screening or by the tankage method and then to discharge it without further treatment into the river. If a more refined treatment is required in the future the effluent from this plant may be carried to the Southwest Works, where ample area is being provided for additional processes.

The full utilization of the diluting and oxidizing power of the river water largely depends upon securing a thorough mixture of the effluent from the works and the water of the river. At each of the three proposed treatment works for Philadelphia it is planned to accomplish this by discharging the effluent through submerged outlets into the main channel of the river.

The distribution of sewage over the surface of percolating filters is one of great importance, as efficient distribution will allow the use of high rates. At Bolton and at Hampton, in England, a traveling distributor is used. This requires but little head, but it is doubtful if it could be successfully used in countries subject to severe winter weather. At Wilmersdorf,

Germany, and in a number of English plants, there are percolator filter installations in which distribution is effected by means of rotary arms. This method accomplishes good distribution but has not been looked upon with favor in America. At Birmingham, distribution is through fixed nozzles operating under a constant head, and this method was followed in the early American installations, but it results in uneven application of the sewage. Latterly this has been improved by the use of the tapered dosing tank with syphonic discharge.

At the Pennypack Creek Works in Philadelphia there is in service a method of distribution through fixed nozzles, operating under a fluctuating head, which yields results equal to that from a mechanical distributor.

THE PENNYPACK CREEK SEWAGE TREATMENT WORKS.

As a part of the work of disposing of the sewage of the city and of protecting the water supply, a treatment works has been constructed and is now in operation on the banks of the Pennypack Creek which empties into the Delaware River 2 000 ft. from the Torresdale water filters. Into this creek there was formerly discharged the sewage of the village of Holmesburg and the large municipal institutions located nearby. Intercepting sewers have been built along the creek, and they conduct the sewage to a pumping station, where it is coarse-screened and passed through a grit chamber and then forced to the treatment works, one third of a mile distant. The plant is designed ultimately to treat 2 000 000 gal. per day and at the present time it is receiving approximately 1 000 000 gal. daily.

The sewage first enters two Emscher tanks, which are of the radial flow type, 30 ft. in diameter and $32\frac{1}{2}$ ft. deep, and having a normal retention period of $2\frac{1}{2}$ hrs. The sludge is withdrawn from the bottom of these tanks through a pipe line, and is discharged by gravity upon a sludge-drying bed composed of layers of sand placed upon broken stone and under-drained by agricultural tile. Instead of the usual method of collecting the effluent of the Emscher tank into a dosing tank from which it would be discharged by a siphon upon the percolating filter, an equalizing tank has been constructed into which the effluent

flows. The bottom of this tank is connected by a 24-in. cast-iron pipe with the distributing system of the percolating filter, and in this line between the equalizing tank and the percolating filter is placed a butterfly valve. The opening and closing of the butterfly valve is controlled by a cam, which is operated through gearing by a water-wheel driven by a small flow of Emscher tank effluent.

The shape of this cam was designed experimentally so as to make the spray from the fixed nozzles alternately move back and forth from the nozzle to a line which produces about six inches overlap of the sprays, and by this means a distribution has been obtained practically equal to that from a mechanical distributor.

To meet the variation in flow, due to the daily fluctuation and to storms, the equalizing tank is electrically connected to the operating machine so that when the flow decreases and the level of the sewage in the tank falls to a predetermined elevation, the machine shuts down and the percolating filter is thrown out of service. When the flow increases and the water rises in the tank, a different cam from that generally in service is automatically thrown in, which causes a longer period of display of the nozzles and cares for the increased flow.

The percolating filter is one acre in area and is divided into five bays, each having its own main distributor. Taylor square nozzles are used, spaced 10.8 ft. apart. The medium is 6 ft. of crushed trap rock, from 1 in. to 3 in. in size. Semi-circular vitrified clay underdrains are laid on a concrete floor, which slopes to the main effluent collectors.

As the function of this plant is the protection of the water of the Delaware River in the immediate vicinity of the intake of the Torresdale water filters, the state department of health required the disinfection of the effluent of the percolating filters, and a plant for this purpose was installed on the line connecting the percolating filters with the final settling basin, consisting of a mixing tank, which rests on the floor of the house and from which the bleach cream is forced by a centrifugal pump to either one of the two solution tanks. Before the bleach solution is added to the sewage it is diluted by a stream of water, and

the very dilute solution flows through a lead pipe, perforated with a large number of small holes, and which lies horizontally in the channel carrying the effluent from the percolating filters. In this way a complete admixture of the disinfectant with the sewage is accomplished, and with only about 25 lbs. of dry bleach per day, which represents one part per million available chlorine, an almost sterile effluent has been produced. The records show that over a period of nineteen weeks only upon one occasion were *B. coli* found in the final effluent. After the sewage has been disinfected it is retained for about two hours in a shallow final settling basin and is then discharged into the creek.

The sewage as received at the treatment works is both fresh and dilute, and by keeping clean the surfaces with which it comes in contact, and by passing it through each of the processes as rapidly as possible, the plant is operated without any odor.

The grounds around the works have been made attractive by the maintenance of well-trimmed grass areas and by planting shrubs and flowering plants.

The sludge withdrawn has been low in moisture, generally about 75 per cent., has contained a considerable amount of gas, and each time it was withdrawn it has been found to be blacker and more granular, showing that the ripening period has been passed and that typical sludge has been obtained.

The final effluent as discharged into the creek has invariably been free from an appreciable amount of suspended matter, perfectly stable and nearly sterilized.

The work so far accomplished has demonstrated the feasibility of the methods suggested for the comprehensive treatment of the sewage of the city. The state board of health having been in touch with the work so far completed, it is anticipated that the plans to be recommended will meet with its approval; and it is hoped that funds will soon be available to commence the work on the larger installations.

BOSTON SOCIETY OF CIVIL ENGINEERS

FOUNDED 1848

INDEX TO ADVERTISERS.

	PAGE
A. B. SEE ELECTRIC ELEVATORS, 111 Devonshire St., Boston.....	XVIII
ABERTHAW CONSTRUCTION CO., 8 Beacon St., Boston.....	XV
ADAMS, H. S., 108 Ames Building, Boston, Mass.....	IV
AMBURSEN COMPANY, 61 Broadway, New York.....	XVII
ASPINWALL & LINCOLN, 3 Hamilton Pl., Boston.....	IV
ASSOCIATED ARCHITECTS PRINTING & SUPPLY CO., 144 Congress St., Boston.....	XVII
ASSOCIATION OF ENGINEERING SOCIETIES, 3817 Olive St., St. Louis..	XVI
BAY STATE DREDGING CO., LTD., 247 Atlantic Ave., Boston.....	X
BISHOP, J. W., & CO., 683 Atlantic Ave., Boston.....	XI
BLAIR, ISAAC, & CO., INC., 433 Harrison Ave., Boston.....	XI
BOSTON PHOTOCOPY PRINT CO., 7 Water St, Boston	XVI
BRADBURY, ROYALL D., 18 Tremont St., Boston.....	III
BRINE, R. S., TRANSPORTATION CO., 43 India St., Boston.....	VIII
BROWN, BURTIS S., 88 Broad St., Boston.....	IV
BUSS, EDWARD A., 85 Water St., Boston.....	IV
DEAN, F. W., INC., 53 State St., Boston.....	IV
DETROIT GRAPHITE CO., 94 Milk St., Boston.....	XVII
EASTERN BRIDGE AND STRUCTURAL CO., Worcester	V
EASTERN EXPANDED METAL CO., 201 Devonshire St., Boston.....	XVI
FORT HILL PRESS, 176 High St., Boston.....	XVIII
FULLER, ANDREW D., CO., 3 Hamilton Pl., Boston.....	XII
FULLER, GEORGE W., 170 Broadway, New York.....	IV
GOW, THE CHARLES R., CO., 166 Devonshire St., Boston.....	XIII
GREEN FUEL ECONOMIZER CO., 141 Milk St., Boston.....	XVI
GURLEY, W. & L. E., Troy, N. Y.....	XIX
HALL, JOHN G., & CO., 114 State St., Boston.....	XVII
HARRINGTON, EPHRAIM, 20 Pemberton Sq., Boston.....	IV
HERING & GREGORY, 170 Broadway, New York.....	IV
HERN, J. L., ENGINEERING CO., 149 Pearl St., Boston.....	IV
HERSEY MFG. CO., South Boston.....	XX
HOLBROOK, CABOT & ROLLINS, CORPN., 6 Beacon St., Boston.	VII
HOLZER, U., 25 Bromfield St., Boston.....	X
HUGHES, EDWARD F., 8 Oliver St., Boston.....	XVII
JACKSON, D. C. & WM. B., 248 Boylston St., Boston.....	IV
JONSBURG, F. F., CO., 733 Old South Building, Boston.....	XI
KELLOGG, ALFRED S., 53 State St., Boston.....	IV
LEDGER & PROBST, 56 Franklin St., Boston.....	XVI
MCQUESTEN CO., THE GEO., 27 Kilby St., Boston.....	XV
MAIN, CHARLES T., 201 Devonshire St., Boston.....	III
MAKEPEACE, B. L., 12 Bromfield St., Boston.....	XVII
METCALF & EDDY, 14 Beacon St., Boston.....	IV

	PAGE
MILLER, HIRAM ALLEN, 8 Beacon St., Boston.....	V
MILLER, WILLIAM L., 71 Alford St., Boston	VIII
NEW ENGLAND BUREAU OF TESTS, INC., 12 Pearl St., Boston....	III
OLD CORNER BOOK STORE, 27 Bromfield St., Boston.....	XVII
PENNSYLVANIA CEMENT CO., 166 Devonshire St., Boston.....	XI
PERRIN, SEAMANS & Co., 57 Oliver St., Boston.....	XVIII
ROCKPORT GRANITE CO., Rockport, Mass.....	VI
SIMPSON BROS. CORPN., 166 Devonshire St., Boston	VI
SMITH, B. F., & Co., 60 Federal St., Boston.....	XV
SPAULDING PRINT PAPER CO., 44 Federal St., Boston.....	XIII
STONE & WEBSTER, 147 Milk St., Boston.....	IX
THOMPSON, SANFORD E., 141 Milk St., Boston.....	V
THOMSON METER CO., 100 Bridge St., New York.....	XV
THORPE, LEWIS D., 201 Devonshire St., Boston.....	V
TUCKER, EDWARD A., Co., 683 Atlantic Ave., Boston.....	VI
TYSON, WEARE & MARSHALL Co., Beacon Building, Boston.....	XVI
WALDO BROTHERS, Boston.....	X
WARREN BROTHERS CO., 59 Temple Place, Boston.....	XIV
WARREN FOUNDRY AND MACHINE CO., 111 Broadway, New York...	VIII
WESTON, ROBERT SPURR, 14 Beacon St., Boston.....	V
WHEELER, CHARLES D., 65 Kilby St., Boston.....	XIII
WHITMAN & HOWARD, 220 Devonshire St., Boston.....	V
WOOD, R. D., & Co., Philadelphia.....	VIII
WORCESTER, J. R., & Co., 79 Milk St., Boston.....	V

CHAS. T. MAIN

ENGINEER

201 Devonshire Street, Boston, Mass.

Rooms 817-833

Plans and Specifications for the erection and equipment or reorganization of textile mills and other industrial plants, including steam and water-power plants

ROYALL D. BRADBURY

Assoc. M. Am. Soc. C. E.

CONSULTING ENGINEER

Structural Steel

Reinforced Concrete

Designs, Specifications, and Estimates

Review and Approval of Plans

Inspection and Supervision of Construction

Examinations and Investigations

Valuations and Appraisals

18 Tremont St., BOSTON

NEW ENGLAND BUREAU OF TESTS, Inc.

Inspecting Engineers and Chemists

Herbert L. Sherman, President

Joshua L. Miner, First Vice-President

A. B. Bellows, Second Vice-President

Wm. F. Zimmermann, Secretary

Tests and inspection of Iron and Steel, Cement and Concrete Materials, Road Materials, Pipe, Wire and Machinery of all kinds.

Chemical Analyses and Research.

Our own laboratories and inspectors at all important points.

12 Pearl Street
BOSTON

'Phone, Fort Hill 3038

H. S. ADAMS**Consulting Engineer****108-9 AMES BUILDING
BOSTON, MASS.****EPHRAIM HARRINGTON****M. Am. Soc. C. E.****Consulting and Advisory Engineer**EXAMINATIONS, ESTIMATES AND REPORTS.
Private and Municipal Improvements and Developments.
PRELIMINARY SURVEYS, DESIGNS AND SUPERVISION.**20 Pemberton Sq.****Boston****ASPINWALL & LINCOLN****Civil Engineers****3 HAMILTON PLACE
BOSTON****HERING & GREGORY****Rudolph Hering John H. Gregory Charles Saville****Consulting Engineers
and Sanitary Experts**

Water Supply and Water Purification, Sewerage, Sewage Disposal and Refuse Disposal

170 Broadway, New York City**BURTIS S. BROWN****Assoc. M. Am. Soc. C. E.****Consulting Engineer**

Designs, Plans, Estimates, Testing. Specialist in Structural Engineering. Fireproof Building Expert. Reinforced Concrete, Structural Steel, Heavy Foundations.

Telephone
Fort Hill 2799919 to 921 Broad Exchange
Building**J. L. HERN ENGINEERING CO.****Consulting Mechanical
Engineering**Heating, Ventilating and Mechanical
EquipmentTel. Fort Hill { 3013
4974149 PEARL STREET
BOSTON, MASS.**EDWARD A. BUSS****Mill Architect and Consulting
Engineer**

New Construction, Rearrangements, Electrical Equipment, Economy of Operation

85 Water St., Boston, Mass.**D. C. & WM. B. JACKSON****Consulting Engineers**FOR ELECTRIC AND
ALLIED PROPERTIESCHICAGO
Harris Trust Bldg.BOSTON
248 Boylston St.**F. W. Dean H. M. Haven Wm. W. Crosby**
Members A. S. M. E.**F. W. DEAN, INC.****Mill Engineers and Architects**Exchange Building, 53 State St.
BOSTON, MASS.**ALFRED S. KELLOGG****Engineering**

Heating, Power and Lighting

53 STATE ST., BOSTON, MASS.**GEORGE W. FULLER****M. Am. Soc. C. E.****M. Am. Inst. Cons. E.****Consulting Hydraulic Engineer and Sanitary Expert****JAMES R. McCLINTOCK****CHAS. B. BUERGER**

Water Supply and Purification, Sewerage and Drainage, Disposal of Sewage and Refuse. Investigation of Epidemics, Water Works Valuations, Supervision of Construction and Operation.

170 Broadway, New York, N. Y.**METCALF & EDDY****Leonard Metcalf****Charles W. Sherman
Almon L. Fales****Harrison P. Eddy****Wm. T. Barnes**14 Beacon Street
Boston, Mass.Harris Trust Building
Chicago, Ill.**Water Supply and Sewerage**

HIRAM ALLEN MILLER

M. Am. Soc. C. E.

Consulting Engineer

Thirty Years' Experience

Expert Work a Specialty

8 BEACON ST., BOSTON, MASS.

ROBERT SPURR WESTONLaboratory for the Analysis of Water,
Sewage, Filtering Materials, etc., Design,
Inspection and Supervision of Water Puri-
fication and Sewage Disposal Plants.

14 BEACON STREET, BOSTON

SANFORD E. THOMPSON

M. Am. Soc. C. E. M. Am. Soc. M. E.

Consulting EngineerDesign of Steel and Reinforced Concrete;
Review of Plans; Estimates and Appraisals;
Tests of Cement and Concrete; Organization of
Construction and Industrial Work.NEWTON HIGHLANDS
MASS.141 MILK ST.
BOSTON**WHITMAN & HOWARD****Civil Engineers**

(Established in 1869)

220 Devonshire Street Room 504
BOSTON**LEWIS D. THORPE****Civil and Sanitary Engineer**Water Works, Sewerage and Sewage
Disposal

Supervision of Construction and Operation

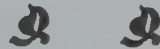
201 Devonshire Street

BOSTON, MASS.

J. R. Worcester E. E. Pettes G. H. Brazer
MEMBERS OF AM. SOC. C. E.**J. R. WORCESTER & CO.****Consulting and Designing
Engineers**Bridges Foundations
Steel and Reinforced Concrete Construction

79 MILK STREET, BOSTON

Cement Testing Laboratory at Waltham, Mass.

EASTERN BRIDGE

— AND —

**STRUCTURAL CO.**

Worcester, Massachusetts,

For Prices on all Classes of

STEEL AND IRON WORK.

WE DESIGN AND MANUFACTURE

ROOF TRUSSES, GIRDERS, COLUMNS, STAIRS
AND FIRE ESCAPES FOR BUILDINGS

FOOT BRIDGES. HIGHWAY BRIDGES, RAILROAD BRIDGES

We Carry a Large Stock of
I-BEAMS, PLATES AND ANGLES

Can Make Quick Deliveries. Send in Your Inquiries.

SIMPSON BROS. CORPORATION



ENGINEERS AND CONTRACTORS FOR REINFORCED CONCRETE CONSTRUCTION

ROCK ASPHALT FLOORS — GRANOLITHIC FLOORS.
SIDEWALKS, CURBING, STEPS, BUTTRESSES, ETC.
SIMBROCO CONCRETE STONE BUILDING TRIM.
FIASSAM CONCRETE STREET PAVEMENT.

ROCKPORT GRANITE

*permanently resists all
action of Sea Water*

It is an undeniable fact that chemical changes take place in the cement of CONCRETE construction exposed for any number of years to sea water, changes that are certainly not for the better.

No changes take place in Rockport Granite. It is permanent, and it is impermeable; and these FACTS are beyond question. The same facts apply to masonry work of every description — Rockport Granite is the ONE material of PERMANENCY.

A combination of Quality and Low Price is offered in Rockport Granite, full details of which will be supplied upon request. Write.

ROCKPORT GRANITE CO. - Rockport, Mass.

C. HARRY ROGERS, Treas. and Gen'l Mgr.

BRANCHES :

New York, 21 Park Row, Represented by F.E. Foster. Chicago, Chamber of Commerce Bldg., Represented by J. D. Duffy. Boston, 31 State St. Winnipeg, Canada, N. J. Dinnen Co.

EDWARD A. TUCKER COMPANY

Concrete Engineers

*Designs and Estimates Submitted Structural Steel
Concrete Reinforcement Fabrication and Erection*

ESSEX BUILDING - 683 ATLANTIC AVENUE, BOSTON

Opp. South Station

Direct Mill Connections

Warehouse, Cambridge

Shop, Camden, N. J.

Telephone, Oxford 4670

Please mention the Journal when writing to Advertisers

Holbrook, Cabot & Rollins Corp'n

Contractors

Heavy Masonry and Concrete Construction, Deep Foundations

6 BEACON STREET BOSTON, MASS.

**Charles Building, 331 Madison Avenue
New York, N. Y.**

JAMES W. ROLLINS, President
FREDERICK HOLBROOK, Vice-Pres., and Gen'l Manager
THOMAS B. BRYSON, Second Vice-President
WILLIAM S. PATTEN, Treasurer

THE

R. S. Brine Transportation Co.

offers its services in connection with the engineering work of members of the Society. Erecting, carting, unloading and rigging all over New England, and can show hundreds of first-class references.

43 India St., BOSTON, MASS.

WILLIAM L. MILLER

71 ALFORD STREET

CHARLESTOWN, MASS.

**Bridge, Docks, Sea Walls, Heavy Timber
and Concrete Construction**

General Contractor

TELEPHONE, 497 CHARLESTOWN

WARREN FOUNDRY AND MACHINE CO.

111 Broadway, New York City

MANUFACTURERS OF

Cast Iron Gas and Water Pipe

ALSO ALL KINDS OF FLANGE PIPE AND SPECIAL CASTINGS

R. D. Wood & Company, **Philadelphia, Pa.**

Engineers Iron Founders Machinists

Pumping Engines, Centrifugal Pumping Machinery, Gas Producer Power Plants (and big installations) Gas Holders, Cast Iron Pipe, Valves and Hydrants, Water and Gas Works Appliances.

Please mention the Journal when writing to Advertisers

STONE & WEBSTER

CHARLES A. STONE EDWIN S. WEBSTER RUSSELL ROBB
 HENRY G. BRADLEE ELIOT WADSWORTH
 DWIGHT P. ROBINSON JOHN W. HALLOWELL

SECURITIES OF PUBLIC SERVICE CORPORATIONS

STONE & WEBSTER ENGINEERING CORPORATION (Incorporated)

CONSTRUCTING ENGINEERS

DWIGHT P. ROBINSON	.	.	.	.	.	President and General Manager
HOWARD L. ROGERS	.	.	.	.	.	First Vice-President and Treasurer
GEORGE O. MUHLFELD	.	.	.	.	.	Vice-President and Construction Manager
FREDERIC N. BUSHNELL	.	.	.	.	.	Vice-President and Engineering Manager
GEORGE C. ENGLAND	.	.	.	.	.	Controller
ROBERT E. HAMILTON	.	.	.	.	.	Purchasing Agent

STONE & WEBSTER MANAGEMENT ASSOCIATION (Incorporated)

GENERAL MANAGERS OF PUBLIC SERVICE CORPORATIONS

HENRY G. BRADLEE	.	.	.	.	.	President
FREDERICK S. PRATT	.	.	.	.	.	Vice-President
FEDRERICK P. ROYCE	.	.	.	.	.	Vice-President
CHARLES F. WALLACE	.	.	.	.	.	Vice-President
HENRY B. SAWYER	.	.	.	.	.	Treasurer

GENERAL MANAGERS OF

The Lowell Electric Light Corporation	Savannah Electric Company
The Seattle Electric Company	Dallas Electric Corporation
Puget Sound Electric Railway	Northern Texas Electric Company
Tacoma Railway and Power Company	The Electric Light and Power Company of Abington and Rockland
Columbus Electric Company	Blackstone Valley Gas & Electric Company
Cape Breton Electric Company, Limited	The Blue Hill Street Railway Company
El Paso Electric Company	Tampa Electric Company
Jacksonville Traction Company	Pensacola Electric Company
Ponce Electric Company	Houston Electric Company
Paducah Traction and Light Company	Fall River Gas Works Company
Puget Sound International Railway & Power Company	Galveston Electric Company
Pacific Northwest Traction Company	Pacific Coast Power Company
The Minneapolis General Electric Company	The Key West Electric Company
Edison Electric Illuminating Company of Brockton	Baton Rouge Electric Company
Houghton County Electric Light Company	Whatecom County Railway & Light Company
Brockton and Plymouth Street Railway Company	Galveston-Houston Electric Company
Houghton County Traction Company	Haverhill Gas Light Company
Dallas Southern Traction Company	Sierra Pacific Electric Company
Eastern Texas Electric Company	Mississippi River Power Company
Fort Worth Southern Traction Company	Puget Sound Traction, Light & Power Company

STONE & WEBSTER BUILDING

147 MILK STREET, BOSTON, MASSACHUSETTS

5 NASSAU STREET, NEW YORK

FIRST NATIONAL BANK BUILDING, CHICAGO

Bay State Dredging Co.
 LTD.
 247 Atlantic Ave. Boston.



**River and Harbor Improvements
 Dock Dredging a Specialty**

A.E. HATCH, Pres. and Mgr. JAMES E. CASHMAN, Treasurer.

WALDO BROTHERS

BOSTON, MASS.



NEW ENGLAND AGENTS FOR
ATLAS PORTLAND CEMENT
AKRON SEWER PIPE

U. HOLZER, BOOK = BINDER

25 BROMFIELD ST., BOSTON, MASS.

ESTABLISHED 1870.

All kinds of Books bound and repaired.

Maps and Charts mounted.

Portfolios, Scrap Books, Blank Books, etc. made to order.

Lettering in Gold; Paper-Splitting; Inlaying; etc.

Photographs Mounted on Card or Paper without Cooking.

**Telephone
 and
 Elevator**

Please mention the Journal when writing to Advertisers

F. F. JONSBURG CO.

Engineering Construction

Switch Cell Construction

733 OLD SOUTH BUILDING
BOSTON

THE EXTREME HIGH QUALITY OF PENNSYLVANIA PORTLAND CEMENT

MAKES ITS USE ESSENTIAL WHERE
WORK OF THE HIGHEST CLASS IS DESIRED

PENNSYLVANIA CEMENT CO.

NEW YORK OFFICE
30 East 42d St.

BOSTON OFFICE
166 Devonshire St.

NEW YORK
53 FIFTH AVENUE

BOSTON
683 ATLANTIC AVENUE

J. W. BISHOP COMPANY GENERAL CONTRACTORS

PROVIDENCE
617 BUTLER EXCHANGE

WORCESTER
109 FOSTER STREET

THIS SPACE
IS
FOR SALE

GEO. A. BLAIR

L. L. STREET

W. O. WELLINGTON

ISAAC BLAIR & CO., Inc., General Contractors

Shoring and Moving Buildings a Specialty

433 Harrison Avenue, BOSTON

Please mention the Journal when writing to Advertisers



ESTATE IN CONCORD, MASS.

T. MOTT SHAW, ARCHITECT

ANDREW D. FULLER CO.**Constructors
Engineers****3 HAMILTON PLACE, BOSTON***Country Estates Complete*

Please mention the Journal when writing to Advertisers

THE CHARLES R. GOW COMPANY
Contractors for Engineering Construction
No. 166 DEVONSHIRE STREET
BOSTON, MASS.

CHARLES D. WHEELER *Insurance*

Telephone 5231 Main

65 KILBY STREET, BOSTON

*Liability, Fire, Life, Accident, Marine
 and Automobile Insurance*

ALSO CONTRACTORS' BONDS AT LOWEST RATES
CONSISTENT WITH ABSOLUTE SECURITY

Spaulding Print Paper Co. ***BLUE PRINTERS***

Blue Prints made from profile and other long tracings in continuous lengths. Small or large orders furnished in the quickest possible time.

A full line of DRAWING MATERIALS in stock at lowest Prices

44 FEDERAL STREET, BOSTON, MASS.

TELEPHONE, MAIN 4103 or 1390

Please mention the Journal when writing to Advertisers

There is No Guesswork in the Construction of THE BITULITHIC PAVEMENT

IT is made of varying sizes of the best stone obtainable, combined with Bituminous Cement, all of which is predetermined by laboratory tests to give the best results and gives the pavement density and "inherent stability" which makes the Bitulithic so popular.



BITULITHIC PAVEMENT, DARTMOUTH ST., BOSTON, MASS.

Pavement laid 1903

Photograph taken Sept., 1913

Now is the Time

¶ You can't build roads in winter but you **CAN** decide what kind of construction to build your roads with next spring. The growth of Bitulithic is phenomenal. From a small yardage of 16,400 square yards in 1901 to over 30,000,500 square yards in 13 years in over 300 cities throughout the United States and Canada, which is equivalent to over 1,700 miles of roadway 30 feet wide between curbs.

¶ You should study the cause of this wonderful growth, and if you are a municipal official it is your duty to know. Your city should not stand in the background but should be in the advance line. It cannot be there without Bitulithic, "the pavement which is built up to a high standard and not down to a low price."

¶ Prepare at once. It is to your advantage to make your contracts now, as 1914 promises extraordinary activity in the street paving line.

¶ Specify Bitulithic and have a pavement that is endorsed by city officials and property owners alike, also highly recommended by automobile owners and drivers.

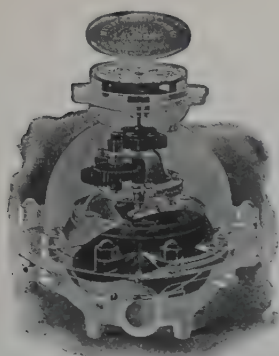
¶ Write today for circulars and learn more about this modern pavement for modern cities.

WARREN BROTHERS COMPANY

Executive Offices : 59 Temple Place, Boston, Mass.

DISTRICT OFFICES	{	NEW YORK, N. Y.	CHICAGO, ILL.	ROCHESTER, N. Y.
		50 Church St.	10 S. La Salle St.	303 Main St., West
		LOS ANGELES, CAL.	PORTLAND, ORE.	PHOENIX, ARIZ.
		926 Calif. Bldg.	Journal Bldg.	204 Noll Bldg.

Please mention the Journal when writing to Advertisers



"LAMBERT" METERS

Made in all sizes from five-eighths to six inch of best bronze composition. Fitted with our unbreakable "Disc" of hard rubber reinforced with a steel plate.

The "Lambert" water meter has made meter systems popular.

THOMSON METER CO.

100-110 BRIDGE STREET BROOKLYN, N. Y

GEO. McQUESTEN CO.

HARD PINE AND OAK LUMBER

Long Lengths and Large Sizes a Specialty
OREGON PINE AND HACKMATAK KNEES

27 KILBY STREET, BOSTON, MASS.

Docks, Yards and Mill at East Boston

ABERTHAW CONSTRUCTION CO.

**Contracting Engineers
Specializing in Concrete**

8 Beacon Street

Boston

We are prepared to undertake the construction of buildings, dams, bridges, tide walls and other structures of reinforced concrete and other materials. This work is done on either the lump sum or the cost-plus-profit basis, the latter being based upon careful accounting methods and cost systems.

(6-17)

Mr. Consumer:

Do you know coal is costing you more yearly ?

Do you know that more than 60 collieries are using economizers to save their coal to sell to others ?

Do you realize that for every 2 tons of coal burned you send a \$ into the blue sky if without an economizer ?

A Green Economizer will stop this.

THE GREEN FUEL ECONOMIZER CO.

H. G. BRINCKERHOFF, Manager

141 Milk Street, Boston

LEDDER & PROBST, Inc.
56 Franklin Street, Boston, Mass.
Surveying Instruments
REPAIRING
BLUE AND BLACK PRINTS
Drawing Materials

We buy, sell, exchange and rent all kinds of instruments

PHOTOCOPY PRINTS

Reproductions made from
Drawings, Blue Prints, Etc.
by the
Photostat Method

BOSTON PHOTOCOPY PRINT CO.
7 WATER ST., BOSTON, MASS.

TYSON, WEARE & MARSHALL CO.
BEACON BUILDING, BOSTON

General Contractors for Buildings on
New Fish Pier, South Boston

C. D. Kirkpatrick, Mgr. - S. P. Gates, Asst. Mgr.

B. F. SMITH & CO., INC.

ESTABLISHED 1878

ARTESIAN AND DRIVEN WELLS
FOUNDATION BORINGS

Engineers and Contractors for Municipal and Private
Water Works

Office: 1st NATIONAL BANK BUILDING,
60 FEDERAL STREET, BOSTON, MASS.

OUR RADIUM BEARING ORES

By L. O. Howard
Utah Society of Engineers
**THE QUANTITY SYSTEM OF ESTIMA-
TING**

By G. Alexander Wright
Technical Society of the Pacific Coast
**THE EFFECT OF SATURATION ON THE
STRENGTH OF CONCRETE: WITH
DISCUSSION**

By J. L. Van Ornum
Engineers' Club of St. Louis
THE STATUS OF THE ENGINEER

Discussion by F. G. Jonah
Engineers' Club of St. Louis
**Journal of the Association of Engineering
Societies, April, 1914. \$3.00 per year.
30 cents per copy.**

JOSEPH W. PETERS, Secretary
3817 Olive St. **ST. LOUIS, MO.**

**EASTERN EXPANDED METAL CO.**

MANUFACTURERS OF EXPANDED METAL

FIRE DOORS, FRAMES AND FITTINGS

201 DEVONSHIRE STREET

BOSTON

Please mention the Journal when writing to Advertisers

JOHN G. HALL & CO.

114 STATE STREET, BOSTON

==PILING==

EDWARD F. HUGHES

Artesian and Driven Wells

for
Manufacturing, Public or Private
Water Supply

954 Oliver Building, 8 Oliver Street, Boston, Mass.
TEL. 1633 MAIN

Engineering Books

THE OLD CORNER BOOK STORE

Have the **Largest Stock** at the **Lowest Prices.** Call and examine. Prompt attention given mail orders.

27-29 BROMFIELD STREET
BOSTON, MASS.

DETROIT GRAPHITE COMPANY

PAINT MAKERS

Special Penstock and Standpipe Paint
"Superior Graphite Paint" for Steel
Bridges and Buildings

94 Milk St., Boston, Mass.

AMBURSEN COMPANY

Engineer-Constructors

Reinforced Concrete Dams and
Hydraulic Work

61 Broadway New York City

Engineering & Drafting Supplies

BLACK LINE AND BLUE PRINTS
SURVEYING INSTRUMENTS REPAIRED

B. L. MAKEPEACE

387 Washington Street
BOSTON - - - MASS.

Associated Architects Printing & Supply Co.

144 CONGRESS STREET, BOSTON

BLUE, BLACK AND VANDYKE PRINTING ON PAPER OR LINEN
BLACK ON WHITE REPRODUCTION PROCESS—ANY COLOR
DRAWING MATERIALS AND SUPPLIES

TELEPHONE, FORT HILL 4013

Please mention the Journal when writing to Advertisers



A. B. SEE ELECTRIC ELEVATORS

Of All Types

Push Button Elevators
Automatically Controlled
for Residences, Etc.

NEW YORK
HARTFORD
PHILADELPHIA
BALTIMORE
WASHINGTON
JERSEY CITY
MONTREAL

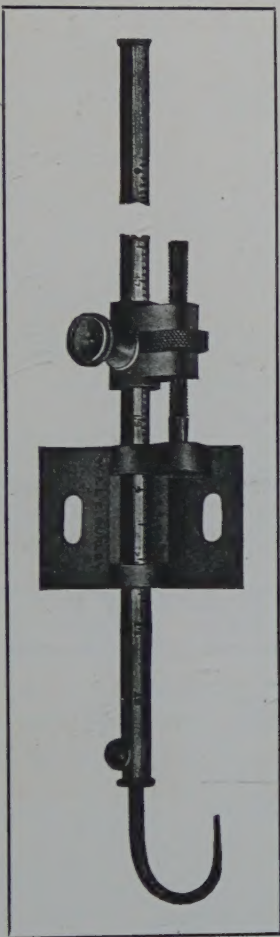
BOSTON OFFICE
MINOT BUILDING
111 Devonshire St.

PERRIN, SEAMANS & CO.

Machinery, Tools and Supplies
FOR
Construction Work

57 OLIVER STREET, BOSTON

Please mention the Journal when writing to Advertisers



Metal Hook Gage

A New and Improved Type

This Hook Gage is made entirely of metal and is nickel plated throughout. The tube is regularly made to read to 2.2 ft., but may be made longer if desired. It is graduated to feet, tenths, and hundredths, and is read to thousandths by a vernier, which is capable of fine adjustment by means of a slow motion screw. Longitudinal holes in the base furnish means for bolting the Gage to the side of the flume. The hook is adjustable within the tube and allows for a movement of 12 inches independent of the Gage, thus permitting it to be set accurately to the exact surface of the water.

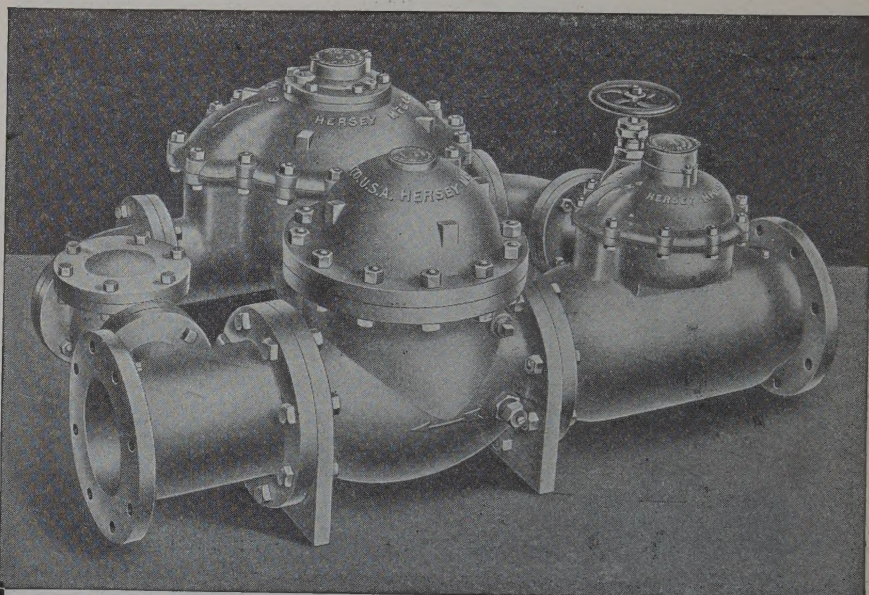
The entire arrangement is such that the readings can be taken by the observer with the greatest possible convenience and at some distance from the surface of the stream or ditch being measured, which is often a decided advantage. This is especially so in the East, where many of the streams are

contaminated by dye stuffs and other undesirable material, rendering it unpleasant for the observer to get too close to the water.

Price \$20.00

W. & L. E. GURLEY
TROY, NEW YORK

Branch Factory SEATTLE, WASH.



STOP WHOLESALE LOSS

USE THE HERSEY DETECTOR-METER

On Fire and Manufacturing Services

THIS IS THE ONLY METER

Endorsed by Water Departments and Underwriters.

Because it registers all large flows.

Because it registers all small flows.

Because it does not obstruct the flow.

HERSEY MFG. COMPANY

Main Office and Works : South Boston, Mass.

BOSTON, MASS., 714 Tremont Temple.

PHILADELPHIA, "The Bourse."

CHICAGO, ILL., 10 So. La Salle Street.

SAN FRANCISCO, 461 Market Street.

NEW YORK CITY, 174 Fulton St.

COLUMBUS, O., 211 Schultz Bldg.

BUFFALO, N. Y., 806 White Bldg.

ATLANTA, GA., 3d Nat. Bank Bldg.

LOS ANGELES, Marsh-Strong Bldg.

"ALL KINDS OF METERS FOR ALL KINDS OF SERVICES"

500,000 SOLD

Please mention the Journal when writing to Advertisers

SPECIAL COMMITTEES — Continued

ON SOCIAL ACTIVITIES

EDMUND M. BLAKE, Chairman

HENRY D. WOODS

GEO. A. CARPENTER

HENRY A. SYMONDS

CLARENCE T. FERNALD

FREDERICK C. H. EICHORN

CHARLES H. EGGLE

LAURENCE B. MANLEY

JOHN N. FERGUSON

CHARLES H. GANNETT

EDWIN R. OLIN

GEO. A. SAMPSON

HERBERT N. CHENEY

LESLIE H. ALLEN

RATES FOR ADVERTISEMENTS

For one year—10 issues

One page	\$75.00
One-half page	40.00
One-quarter page	25.00
One-sixth page	17.50
One-eighth page	14.00
One-twelfth page	10.00

Last page, 50 per cent. additional.

For further information, or for contract forms, address

EDWARD C. SHERMAN, Editor,
6 Beacon Street, Boston.

